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A METHOD TO CORRELATE THE UPPER AIR DENSITY WITH SURFACE DENSIT--ETC(U)
JUL 82 L J MCANELLY
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Atmospheric data collected twice daily from five ocean stations over a period of 7 years were used in a study to correlate ballistic densities at various levels. The study indicates that a good correlation does exist and that tables, nomograms, or data in a suitable format should be produced for use with new and existing fire control computers and range tables prepared for the Fleet.

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20. ABSTRACT (Cont.)

Two exponential functions of altitude were used to express the density—one from surface to 36,000 ft, the other from 36,000 to 65,000 ft. The coefficients were selected in a manner that produces a continuous function from sea level to 65,000 ft. The coefficients of the two functions were determined using a non-linear least-squares technique.

Fluctuations in the density profiles below 5,000 ft altitude were noted and were investigated by fitting a sample of temperature and pressure data with a least-squares technique.

Ballistic densities for firing at surface targets were computed for altitudes to 50,000 ft. While the current projectiles in the Fleet may not reach an altitude of 50,000 ft, this may become a reality in the near future. The procedure presented in this report could very easily be modified to compute ballistic density when firing at air targets at altitudes up to 50,000 ft.

FOREWORD

The range tables for Navy guns include a nomogram for computing ballistic density, which may be used when only the surface density is known. While these nomograms are intended for use when better estimates of ballistic density are not available, they are based on data prepared in 1922, despite the advent of radiosondes and the establishment of ocean weather stations.

Since there frequently are times when a radiosonde observation cannot be made in the immediate operating area just before firing, or a timely and applicable meteorological message from the Fleet Numerical Weather Center (FNWC) is not available, another method for obtaining ballistic densities would serve a useful purpose.

This report documents a study that shows that ballistic densities can be estimated from the surface density with a reasonable degree of accuracy. Data are also presented about the upper atmosphere which may be useful when further studies pertaining to the atmosphere are conducted.

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INTRODUCTION

One of the basic premises of fire control systems in use in the Fleet today is a "Standard Atmosphere." Obviously, the same premise is also used in the preparation of ballistic tables for the Fleet. Since the conditions used as a basis for a standard atmosphere are rarely encountered on earth, corrections for nonstandard conditions are always in order. A procedure frequently used to correct for a non-standard density involves a ballistic air density in the solution of fire control problems. The ballistic air density may be defined as a scale factor that, when multiplied by the standard air density at each altitude, produces a density structure that would cause the same displacement of a projectile impact point as the actual density structure.

The most reliable method of determining ballistic density is to use accurate, representative, and timely meteorological observations in the computation. There are, however, occasions when these measurements are not available, and alternate methods are necessary to provide the requisite information. It is a standard procedure to include a nomogram in the ballistic tables for the Fleet. The use of the nomogram is an alternative that is available to the Fleet for estimating the upper air density for naval gunfire when a ballistic meteorological forecast is not available. The nomograms may be used to estimate the ballistic density when the air temperature, pressure, and relative humidity at the surface are known.

The basic data used to prepare the nomograms were obtained from Table IV, The Ballistic Density Factor,[1] which was published in 1935. A footnote to this table states, "This table has been extracted from Table C of a pamphlet entitled Method for Determining Air Temperature and Ballistic Air Density, published by the Signal Corps (Meteorological Service), U.S. Army in 1922."

Fire control systems have been improved to the point where an accurate determination of the upper air density is required if the potential of the systems is to be fully utilized. The need for improving the nomograms or providing an alternate procedure to determine the ballistic density has long been recognized.

The work described in this report, stated briefly, consisted of (1) obtaining Rawinsonde data from various weather stations, (2) sorting the data according to

surface densities and seasons, (3) fitting the upper air densities with a least-squares technique, and (4) computing ballistic densities.

Rawinsonde data used in the study were obtained from five maritime stations which took soundings daily at 0000 and 1200 hr G.m.t. over a period from 1968 to 1973. The data, consisting of both significant and mandatory levels, were provided by the National Climatic Center, Asheville, North Carolina. Mandatory levels are specified pressure altitudes, which are obtained by interpolation. Significant levels are the altitudes that are considered essential in defining a weather profile. Soundings that did not include surface density were not used in the study. Some of the obvious errors were eliminated in processing the data prior to performing the least-squares fit, but no attempt was made to eliminate errors in the basic data beyond that point.

The geodetic coordinates of the five stations used in the study are listed below:

Station Name	Latitude	Longitude
E	35° 0' N	48° 0' W
V	34° 0' N	164° 0' E
C	52° 45' N	35° 30' W
D	44° 0' N	41° 0' W
N	30° 0' N	140° 0'W

A map of the stations is shown in Figure 1.

No land-based stations were used in the analysis, even though naval gunfire support is conducted on beach areas. Since the density correlations are markedly affected by the nature of the terrain,[2] there is more than a probability that somewhat different results would be obtained for different littoral areas of the earth.

All computer programs used in the study were coded in FORTRAN EXTENDED and were executed with a Control Data Corporation (CDC) 6700 computer.

The purpose of performing the work described in this report was to establish a procedure to determine the correlation between upper air and surface densities and

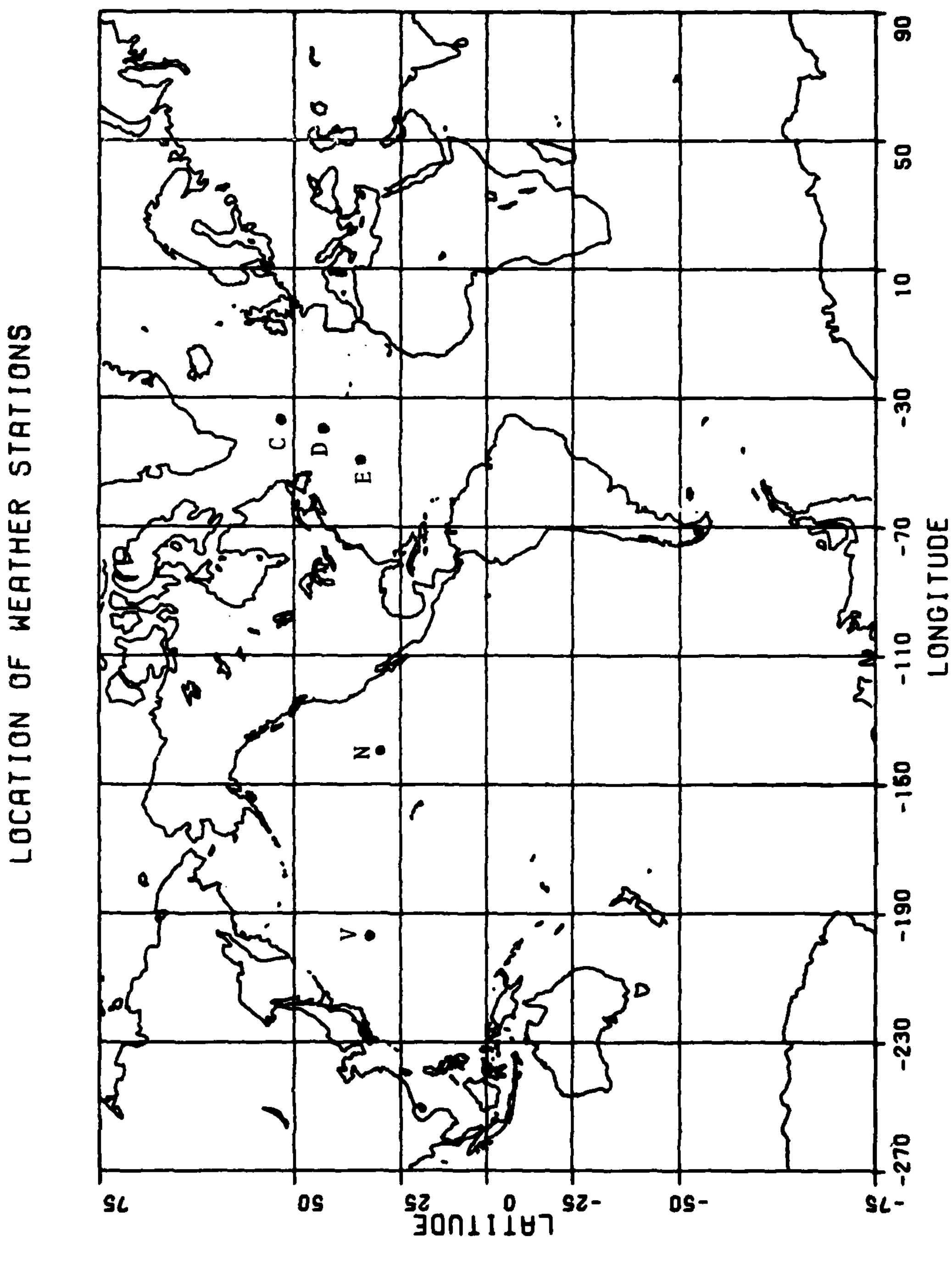

FIGURE 1. MAP OF STATIONS USED IN THE STUDY

to devise a method for estimating the ballistic air density based on surface conditions.

DETAILED PROCEDURE

The first step in the procedure was to compute the air density using the temperature, pressure, and relative humidity. The geopotential altitudes were converted to geometric altitudes. Sondes that did not include surface conditions were omitted. The data for each station were sorted into two groups according to the time of day and stored in permanent files with the Indexed-Sequential File Organization. This procedure permits accessing the data in either a sequential or random order. The sondes were assigned indices which were stored in separate sequential files. One file of indices was created with the corresponding surface densities in ascending numerical order, and a second file was created with the surface densities also sorted into the four seasons. A follow-up program was designed to skip specified segments when the files were read. This made it convenient to group the data in various ways without rearranging the Indexed-Sequential files.

The data were then selected in groups where the median surface density of each group varied by a percentage point from the U.S. Standard surface density as defined in Reference 3 (i.e., into classes by surface density ratios where the class interval was one percent). Since large variations were encountered in the frequency of the surface densities, it was necessary to eliminate some of the sondes in the mid-ranges. Several fits were made using various numbers of samples in each fit. No significant differences were obtained by using more than 25 samples; consequently, a further restriction was placed on each group that limited the number of sondes to 25. While some of the groups outside the mid-ranges had variations in surface densities of one percent, the actual number of samples was, in some cases, less than 25. In contrast, some of the groups of 25 samples in the mid-ranges had variations in surface densities of only a fraction of one percent.

Various functions were investigated to represent a mean density profile for each group of data. Comparisons were made of three different functions for representing the density in the altitude range from 0 to 36,089 ft:

1. a third-degree polynomial
2. a third-degree polynomial for the ratio of the observed density to the U.S. Standard density
3. an exponential function plus a linear term

While these three functions produced similar results, the exponential function was selected. The fitting technique is described in Appendix A. The following expression was used in the altitude range from 0 to 36,089 ft:

$$\rho = c_1 e^{(c_2 h)} + c_3 h \tag{1}$$

where,

ρ is the density (lb/ft^3)
h is the altitude (ft)
c_1, c_2, and c_3 are constants determined by the fit

A similar expression was used to fit the data in the region from 36,089- to 65,000-ft altitude:

$$\rho = \rho_{36089}\, e^{(c_4*(h - 36089))} + c_5*(h - 36089) \tag{2}$$

where,

ρ_{36089} is the density at 36,089 ft, computed using equation (1) and the data up to 36,089 ft
c_4 and c_5 are coefficients determined in the fit above 36,089 ft

A bias was noted in the lower altitudes with each of the three methods. After some experimenting, data below 3,500 ft were excluded from the fit to determine the coefficients. The fit was then extrapolated to mean sea level, and a linear correction was added from 0 to 3,500 ft, which made ρ equal to ρ_0 at the surface:

$$\rho = c_1 e^{(c_2 h)} + c_3 h + (\rho_0 - c_1)(3500 - h)/3500 \tag{3}$$

where,

ρ is the density (lb/ft^3)

c_1, c_2, and c_3 are the coefficients obtained with equation (1)

h is the altitude (ft)

ρ_0 is the median of the observed surface densities (lb/ft^3)

Although this procedure does not use any of the available data between surface and 3,500 ft in the least-squares fit to determine the coefficients c_1, c_2, and c_3, residuals from the fit in this region are included in the analysis. Adding the linear correction made a significant improvement in the residuals from surface to 3,500 ft.

The upper boundary of 36,089 ft was selected from the zone where equation (1) was used in order to coincide with the breakpoint in the U.S. Standard atmosphere. While there are some seasonal, latitudinal, and diurnal variations in the isopycnic level where the density remains nearly constant, no attempt was made to explore this facet.

After fitting the observed density data, using equations (1) and (2), density profiles were computed using equations (2) and (3) with the coefficients obtained in the least-squares fit. Ballistic densities for each profile were computed with the equation,

$$\text{Ballistic Density} = \sum_{i=1}^{n} (WF_i * R_i) \tag{4}$$

where,

n is the number of zones

WF_i is the density weighting factor for the ith zone

R_i is the ratio of the mean density of the ith zone of the profile to the U.S. Standard density at that altitude, which is the mid-point of the ith zone.

The density weighting factors used to compute the ballistic density were obtained by computing trajectories with ballistic parameters for the 5-Inch High Fragmentation Projectile fired with a Mk 73 charge, which produces an initial velocity of 2,950 ft/sec. The altitudes covered by each zone are presented in Table 1, and a tabulation of the weighting factors are presented in Table 2.

TABLE 1. ALTITUDE OF ZONES

Zone	Altitude (ft)	Zone	Altitude (ft)	Zone	Altitude (ft)
1	0 - 1,000	10	9,000 - 10,000	19	26,000 - 28,000
2	1,000 - 2,000	11	10,000 - 12,000	20	28,000 - 30,000
3	2,000 - 3,000	12	12,000 - 14,000	21	30,000 - 32,000
4	3,000 - 4,000	13	14,000 - 16,000	22	32,000 - 34,000
5	4,000 - 5,000	14	16,000 - 18,000	23	34,000 - 36,000
6	5,000 - 6,000	15	18,000 - 20,000	24	36,000 - 38,000
7	6,000 - 7,000	16	20,000 - 22,000	25	38,000 - 40,000
8	7,000 - 8,000	17	22,000 - 24,000	26	40,000 - 45,000
9	8,000 - 9,000	18	24,000 - 26,000	27	45,000 - 50,000

FITTING A SAMPLE SET OF DATA WITH AN ALTERNATE PROCEDURE

An alternate method was used to fit a sample set of data in the region from surface to 36,000 ft. In this procedure, the virtual temperature was computed, using the observed temperature and relative humidity. Separate least-squares fits were then made to the virtual temperatures and pressures. The temperature and pressure profiles obtained in this manner were then used to compute the density. This procedure and the results are described in detail in Appendix B. The sample set of data was obtained from 25 sondes that had been selected previously for fitting with equation (1). The sondes were observed at Station E during the spring season, 1200 hr G.m.t., on days that had a surface density close to the U.S. Standard density at mean sea level.

TABLE 2. DENSITY WEIGHTING FACTORS

ZONES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	1.000																										
2	0.375	0.625																									
3	0.251	0.265	0.485																								
4	0.192	0.194	0.210	0.404																							
5	0.159	0.157	0.159	0.176	0.349																						
6	0.138	0.135	0.134	0.136	0.151	0.307																					
7	0.122	0.119	0.118	0.117	0.119	0.133	0.272																				
8	0.111	0.108	0.105	0.104	0.104	0.106	0.117	0.244																			
9	0.102	0.099	0.097	0.095	0.093	0.093	0.095	0.106	0.220																		
10	0.095	0.092	0.090	0.087	0.086	0.085	0.084	0.087	0.096	0.200																	
11	0.084	0.081	0.079	0.077	0.075	0.073	0.072	0.071	0.070	0.072	0.247																
12	0.075	0.074	0.071	0.069	0.067	0.065	0.064	0.062	0.061	0.060	0.122	0.210															
13	0.069	0.067	0.065	0.063	0.062	0.060	0.058	0.056	0.055	0.053	0.105	0.106	0.180														
14	0.065	0.063	0.061	0.059	0.057	0.055	0.054	0.052	0.050	0.050	0.095	0.092	0.093	0.156													
15	0.061	0.059	0.057	0.055	0.053	0.052	0.050	0.049	0.047	0.046	0.088	0.085	0.081	0.082	0.135												
16	0.057	0.056	0.054	0.052	0.050	0.049	0.048	0.046	0.045	0.043	0.083	0.078	0.074	0.072	0.073	0.119											
17	0.055	0.053	0.051	0.050	0.048	0.047	0.045	0.044	0.042	0.041	0.079	0.074	0.070	0.067	0.064	0.065	0.104										
18	0.052	0.051	0.049	0.048	0.046	0.044	0.044	0.042	0.040	0.040	0.075	0.071	0.067	0.063	0.060	0.058	0.058	0.091									
19	0.050	0.049	0.047	0.045	0.044	0.043	0.041	0.040	0.039	0.038	0.072	0.068	0.065	0.061	0.059	0.055	0.053	0.052	0.079								
20	0.048	0.047	0.045	0.044	0.043	0.041	0.040	0.039	0.037	0.037	0.069	0.066	0.062	0.058	0.056	0.053	0.051	0.048	0.047	0.069							
21	0.047	0.045	0.044	0.042	0.041	0.040	0.039	0.038	0.036	0.035	0.067	0.063	0.060	0.056	0.053	0.050	0.049	0.047	0.045	0.043	0.060						
22	0.046	0.044	0.043	0.041	0.040	0.039	0.038	0.037	0.035	0.034	0.065	0.061	0.057	0.054	0.051	0.048	0.046	0.043	0.043	0.042	0.039	0.053					
23	0.045	0.044	0.042	0.041	0.039	0.038	0.037	0.036	0.034	0.033	0.064	0.060	0.055	0.053	0.049	0.046	0.043	0.042	0.040	0.038	0.038	0.036	0.046				
24	0.044	0.043	0.042	0.040	0.039	0.038	0.037	0.036	0.034	0.034	0.063	0.059	0.055	0.052	0.048	0.045	0.042	0.040	0.037	0.035	0.034	0.034	0.033	0.035			
25	0.043	0.042	0.041	0.040	0.038	0.037	0.036	0.034	0.034	0.032	0.062	0.058	0.054	0.050	0.047	0.044	0.041	0.039	0.036	0.034	0.033	0.031	0.032	0.031	0.032		
26	0.042	0.041	0.039	0.037	0.038	0.036	0.035	0.033	0.032	0.031	0.059	0.056	0.053	0.049	0.045	0.043	0.039	0.037	0.035	0.032	0.031	0.028	0.028	0.026	0.025	0.050	
27	0.041	0.040	0.039	0.037	0.036	0.035	0.034	0.033	0.032	0.030	0.059	0.055	0.051	0.047	0.044	0.042	0.038	0.037	0.034	0.032	0.029	0.027	0.025	0.024	0.023	0.049	0.027

The purpose of using the alternate method was to evaluate the method described in the section Procedure and to provide additional information about the atmosphere, particularly in the lower altitudes.

While this method is a good procedure for providing temperature, pressure, and density profiles, it is a more time-consuming method for obtaining density profiles than the method of making a least-squares fit to the densities.

The density profile obtained with this method did not result in a noticeably different profile, but it did provide additional information about the temperature and pressure. The pressure data from surface to 36,000-ft altitude were fit with a single function that has a continuous derivative. The temperature data were divided into three altitude zones. Separate least-squares fits were made to each zone in a manner that made the curve continuous but with a different lapse rate in each zone. The improvement in using the correction term in equation (3) to fit the density is largely due to the variations in the temperature lapse rate at the lower altitudes.

FITTING THE U.S. STANDARD ATMOSPHERE

In order to further test the least-squares method and the exponential representation of the density, a fit was made to the U.S. Standard density, using equations (1) and (2). Since the U.S. Standard temperature has a constant lapse rate from surface to 36,089-ft altitude, the correction term in equation (3) was not used. It should be noted that equations (1) and (2) were not intended to define the U.S. Standard density but were selected to fit the observed data. However, the standard deviations in the fit were only 0.14 and 0.28 percent in the zones from 0- to 36,089-ft, and 36,089- to 65,000-ft altitude, respectively. Since the density varies with altitude, the residuals were expressed as ratios of the U.S. Standard density at the corresponding altitude. A tabulation of the fit is presented in Tables 3 and 4.

TABLE 3. LEAST-SQUARES FIT OF U.S. STANDARD DENSITY
0 - 36,000 ft

1 Altitude (ft)	2 U.S. Standard Density (lb/ft^3)	3 L. S. Fit Density (lb/ft^3)	4 $\frac{\text{Col. 2 - Col. 3}}{\text{Col. 3}}$
0.	0.076474	0.07665845	-0.00240610
500.	0.075362	0.07551388	-0.00201122
1,000.	0.074262	0.07438439	-0.00164533
1,500.	0.073174	0.07326977	-0.00130712
2,000.	0.072098	0.07216982	-0.00099517
2,500.	0.071035	0.07108433	-0.00069395
3,000.	0.069984	0.07001309	-0.00041553
3,500.	0.068945	0.06895591	-0.00015824
4,000.	0.067917	0.06791259	0.00006494
4,500.	0.066902	0.06688293	0.00028510
5,000.	0.065898	0.06586675	0.00047450
5,500.	0.064906	0.06486384	0.00064991
6,000.	0.063925	0.06387404	0.00079783
6,500.	0.062956	0.06289715	0.00093568
7,000.	0.061998	0.06193299	0.00104969
7,500.	0.061051	0.06098138	0.00114159
8,000.	0.060116	0.06004216	0.00122986
8,500.	0.059191	0.05911513	0.00128338
9,000.	0.058278	0.05820014	0.00133776
9,500.	0.057375	0.05729702	0.00136106
10,000.	0.056483	0.05640559	0.00137245
10,500.	0.055602	0.05552569	0.00137431
11,000.	0.054731	0.05465717	0.00135085
11,500.	0.053871	0.05379985	0.00132241
12,000.	0.053022	0.05295360	0.00129174
12,500.	0.052182	0.05211824	0.00122336
13,000.	0.051353	0.05129363	0.00115745
13,500.	0.050534	0.05047962	0.00107734
14,000.	0.049725	0.04967605	0.00098539
14,500.	0.048926	0.04888278	0.00088407
15,000.	0.048137	0.04809968	0.00077598
15,500.	0.047358	0.04732658	0.00066389
16,000.	0.046589	0.04656336	0.00055067
16,500.	0.045829	0.04580987	0.00041754
17,000.	0.045079	0.04506598	0.00028881
17,500.	0.044338	0.04433156	0.00014526
18,000.	0.043606	0.04360647	-0.00001072
18,500.	0.042884	0.04289057	-0.00015329

TABLE 3. LEAST-SQUARES FIT OF U.S. STANDARD DENSITY
0 - 36,000 ft (Continued)

1 Altitude (ft)	2 U.S. Standard Density (lb/ft^3)	3 L. S. Fit Density (lb/ft^3)	4 $\frac{\text{Col. 2 - Col. 3}}{\text{Col. 3}}$
19,000.	0.042171	0.04218375	-0.00030232
19,500.	0.041468	0.04148588	-0.00043087
20,000.	0.040773	0.04079682	-0.00058376
20,500.	0.040087	0.04011645	-0.00073413
21,000.	0.039410	0.03944466	-0.00087867
21,500.	0.038742	0.03878132	-0.00101387
22,000.	0.038083	0.03812631	-0.00113606
22,500.	0.037432	0.03747953	-0.00126803
23,000.	0.036790	0.03684084	-0.00137995
23,500.	0.036156	0.03621014	-0.00149516
24,000.	0.035531	0.03558732	-0.00158251
24,500.	0.034914	0.03497226	-0.00166590
25,000.	0.034306	0.03436486	-0.00171279
25,500.	0.033705	0.03376501	-0.00177724
26,000.	0.033113	0.03317260	-0.00179668
26,500.	0.032529	0.03258753	-0.00179614
27,000.	0.031952	0.03200970	-0.00180254
27,500.	0.031384	0.03143900	-0.00174942
28,000.	0.030823	0.03087534	-0.00169508
28,500.	0.030270	0.03031861	-0.00160323
29,000.	0.029725	0.02976872	-0.00146858
29,500.	0.029187	0.02922557	-0.00131974
30,000.	0.028657	0.02868907	-0.00111786
30,500.	0.028134	0.02815913	-0.00089227
31,000.	0.027619	0.02763564	-0.00060224
31,500.	0.027110	0.02711853	-0.00031466
32,000.	0.026610	0.02660771	0.00008623
32,500.	0.026116	0.02610307	0.00049524
33,000.	0.025629	0.02560455	0.00095501
33,500.	0.025149	0.02511204	0.00147165
34,000.	0.024676	0.02462548	0.00205161
34,500.	0.024210	0.02414477	0.00270177
35,000.	0.023751	0.02366983	0.00342940
36,000.	0.022853	0.02273694	0.00510442

Mean of Column 4 -0.00000178

Standard Deviation of Column 4 0.00140643

TABLE 4. LEAST-SQUARES FIT OF U.S. STANDARD DENSITY
36,200 - 65,000 ft

1 Altitude (ft)	2 U.S. Standard Density (lb/ft^3)	3 L. S. Fit Density (lb/ft^3)	4 $\frac{\text{Col. 2 - Col. 3}}{\text{Col. 3}}$
36200.	0.022666	0.02253574	0.00578032
37000.	0.021814	0.02169457	0.00550490
38000.	0.020794	0.02068713	0.00516582
39000.	0.019822	0.01972648	0.00484233
40000.	0.018895	0.01881043	0.00449577
41000.	0.018012	0.01793693	0.00418541
42000.	0.017170	0.01710398	0.00385968
43000.	0.016367	0.01630972	0.00351190
44000.	0.015602	0.01555234	0.00319287
45000.	0.014873	0.01483014	0.00289033
46000.	0.014178	0.01414147	0.00258344
47000.	0.013516	0.01348478	0.00231541
48000.	0.012884	0.01285858	0.00197664
49000.	0.012282	0.01226147	0.00167447
50000.	0.011709	0.01169208	0.00144691
51000.	0.011162	0.01114914	0.00115366
52000.	0.010641	0.01063141	0.00090240
53000.	0.010144	0.01013772	0.00061976
54000.	0.0096701	0.00966695	0.00032545
55000.	0.0092186	0.00921805	0.00005944
56000.	0.0087882	0.00879000	-0.00020437
57000.	0.0083780	0.00838182	-0.00045561
58000.	0.0079870	0.00799260	-0.00070018
59000.	0.0076142	0.00762145	-0.00095105
60000.	0.0072589	0.00726754	-0.00118830
61000.	0.0069202	0.00693006	-0.00142260
62000.	0.0065973	0.00660825	-0.00165751
63000.	0.0062895	0.00630139	-0.00188719
64000.	0.0059961	0.00600878	-0.00211035
65000.	0.0057164	0.00572976	-0.00233130

Mean of Column 4 0.00003016

Standard Deviation of Column 4 0.00284086

The following equations were used in the least-squares fit of the U.S. Standard density:

$0 \leq h \leq 36089$

$$\rho = c_1 e^{(c_2 h)} + c_3 h$$

$36{,}089 \leq h \leq 65{,}000$

$$\rho = \rho_{36089}\, e^{(c_4 * (h - 36089)} + c_5 * (h - 36089)$$

where

h is the altitude (ft)

The coefficients obtained in the least-squares fit are:

c_1 = 0.0766584476 (lb/ft^3)
c_2 = -0.282539693789 E-4 (ft^{-1})
c_3 = -0.138466611596 E-6 (lb/ft^4)
ρ_{36089} = 0.0226549960 (lb/ft^3)
c_4 = -0.475504250122 E-4 (ft^{-1})
c_5 = 0.459663274698 E-11 (lb/ft^3)

RESULTS

The coefficients that were obtained by fitting the density data, and the root mean squares (rms) or standard deviation of the residuals and their algebraic means are given in Appendix C for the five stations analyzed. Data are presented for two times of day (0000 and 1200 hr G.m.t.) for the four seasons and for the seasons combined for each station.

Profiles of the density ratios for station E are given in Appendix D. The ratios were obtained by evaluating the least-squares fit of the observed densities at specified altitudes and dividing the density in each case by the U.S. Standard

density for the same altitude. Profiles are shown for the two times of day for each of the four seasons and for the seasons combined.

Profiles of the ballistic densities obtained by multiplying the ratios with the density weighting factors using equation (4) are shown in Appendix E for station E for the same conditions. Density ratios and ballistic densities were computed for each of the five stations, but the profiles are shown only for station E in Appendixes D and E.

While the ballistic densities were computed for the 27 zones listed in Table 1, only an abbreviated tabulation is given in Appendix F. Data are presented for only two zones, 30,000 and 50,000 ft. The ballistic densities were computed with equation (4), using the density weighting factors given in Table 2. Data for the two zones are given for each of the five stations and for each surface condition where sufficient data were available to make a least-squares fit to the observed data.

DISCUSSION OF RESULTS

One question is of primary interest—is there sufficient correlation between surface density and that of the upper atmosphere to accurately predict the ballistic density for various altitudes from surface measurements? To answer this question, we first note that the density ratio curves given in Appendix D for station E are families of very similiar curves. If some of the curves were missing, we could do a fair job of reproducing the curves by interpolation. This would seem to indicate, qualitatively at least, that one could predict the density ratios aloft from the starting point of the curve on the x-axis, which is the surface density ratio. The same is true of the curves given for ballistic density in Appendix E. It deserves mentioning that the points plotted in Appendix D are not the mean values of individual sondes but are values corresponding to the functional fit.

The sondes were grouped in order that a more reliable mean and standard deviation could be established. It is recognized that the curves in Appendix D do not reflect the errors of the means or the variations in the upper atmosphere within a

group of sondes. A total of 14,800 sondes were processed in this study in an attempt to establish reliable means and standard deviations. In every fit, the mean and standard deviation were computed. These are tabulated in Appendix C. A large majority of the means are only a small fraction of one percent.
The standard deviations of the residuals are given in Table 5 according to percentiles. A total of 300 fits was made in each of the two altitude zones, 0 to 36,000 and 36,000 to 65,000 ft. The standard deviations of the residuals were arranged in numerical order without regard to station, season, or time of day. The standard deviation of the 50th percentile is 1.114 percent in the lower altitude zone.

TABLE 5. STANDARD DEVIATIONS OF THE RESIDUALS

Percentile	Altitude 0 - 36,000 (ft) (%)	Altitude 36,000 - 65,000 (ft) (%)
10	0.675	2.019
20	0.799	2.293
30	0.908	2.586
40	1.000	2.832
50	1.114	3.067
60	1.227	3.295
70	1.424	3.584
80	1.577	3.959
90	1.703	4.298
100	2.257	6.377

Note: The standard deviations in this table were obtained by multiplying the standard deviations (SIGMA) in Appendix C by 100 in order to express them as a percentage instead of as a ratio.

It should also be remembered that there are variations in the surface densities because of grouping the data, which probably has a neglible effect on the means but makes a small contribution to the standard deviations. The noise level in the data appears to increase with altitude, which is to be expected. The residuals are much larger in the fits above 36,000 ft than they are at the lower altitudes, while the density should be more stable at the higher altitudes.

It may be noted that the ballistic density represents a weighted average of the density ratios. Accordingly, any fluctuations that are random, and that may be

present in the ratios of the true density to the mean density, would tend to average out in computing the ballistic density.

Another question that deserves consideration is—how important is geographic location, season, and time of day? Only five stations used in the study are located in wide ocean areas, far from land, and between 30° and 50° N latitude. Data were available for only two times of day, 0000 and 1200 hr G.m.t., which makes it difficult to determine the diurnal variations. Based on the data available, there does not seem to be much payoff for preparing separate tables for different times of day and different seasons for the geographic areas that might be represented by the five stations.

There does appear to be a significant difference between the correlates of stations E, N, and C, North latitudes 35°, 50°, and 52° 45', respectively. The ballistic density at 30,000 ft, corresponding to the same surface density, is about one-half percent higher at the lower latitude stations than at station C. The surface densities run higher at station C. The upper air density may decrease more rapidly than it does at the other stations, resulting in lower ballistic densities for the same surface density.

Data by season do not appear to correlate differently, except at station C. The largest difference noted here was for surface density 1.03, where the ballistic density at 30,000 ft was about one percent lower in summer than in other seasons.

While the procedure presented in this report has been used on only five stations that have an oceanic climate, it should be possible to use essentially the same procedure for processing data from stations where the climate is more affected by land masses. Some modifications might be required, since the temperature lapse rate might be quite different. The diurnal and seasonal variations in pressure and temperature are normally much larger over land masses than they are over large bodies of water.

A similar but earlier study[2] was made by the Army Electronics Command, Fort Monmouth, New Jersey. Data from land-based stations were used in this study and a number of tables were prepared for each geographic area, season, and time of day.

CONCLUSIONS

1. There does appear to be a good correlation between the surface density and the density at various altitudes over the mid-ocean areas studied.

2. The resulting correlations are different for different latitudes. They do not change appreciably with diurnal time or season over the areas studied.

3. The differences between surface and upper atmospheric conditions are much larger over littoral areas.

4. The procedure described in this report for determining the correlation between upper air density and the surface density may be used for a variety of stations with only minor modifications to the procedure.

5. While the procedure for estimating ballistic density was developed primarily for firing Navy guns, it may also be useful to predict the ballistic density for air-launched missiles.

6. It is estimated that the density ratios at altitudes not to exceed 36,000 ft may be predicted with an error not to exceed 1.0 percent, using the correlation between the surface density and the density of the upper atmosphere.

7. It is estimated that the ballistic density may be predicted with an error not to exceed 0.5 percent in 90 percent of the cases where the altitude does not exceed 36,000 ft.

8. It is estimated that the ballistic density may be predicted with an error between one and two percent where the altitude is between 36,000 and 50,000 ft. This error could be reduced somewhat if the data used in the study had been collected with present day equipment.

RECOMMENDATIONS

1. Correlations should be obtained for other latitudes, including both maritime and beach areas of strategic importance.

2. More data should be obtained for the extremely low and high surface densities.

3. A further study should be conducted to determine how the procedure of estimating the ballistic density, as described in this report, could be implemented in fire control systems and in preparation of range tables.

4. Consideration should be given to using the analytic expression for density in computer programs that simulate the trajectories of unguided missiles.

REFERENCES

1. U.S. Naval Academy, *Range and Ballistic Tables, 1935*, p. 84.

2. Marvin J. Lowenthal, *The Accuracy of Ballistic Density Departure Tables 1934-1972*, ECOM-5436, OSD 1366 (April 1972).

3. Committee on Extension to the Standard Atmosphere, *U.S. Standard Atmosphere, 1976*, (Washington, D.C.: Government Printing Office, 1976).

APPENDIX A

A NONLINEAR LEAST-SQUARES TECHNIQUE

A NONLINEAR LEAST-SQUARES TECHNIQUE

Statement of the Problem

Let (x_i, y_i), $i = 1,2, \ldots, N$ be a set of N data points and

$$f(x, a_1, a_2, \ldots, a_M) \tag{A-1}$$

be a function with x as the independent variable. (a_j), $j = 1,2, \ldots, M$ are parameters of the function and the function may not be linear in these parameters.

We would like to determine values of the M parameters such that

$$F(a_1, a_2, \ldots, a_M) = \sum_{i=1}^{i=N} W_i[Y_i - f(x_i, a_1, a_2, \ldots, a_M)]^2 \tag{A-2}$$

is a minimum. This is the least-squares solution, which is the same as minimizing the sum of the squares of the residuals. A weight W_i is assigned to each data point.

For simplicity of notation, we let

$$f_i(a) = f(x_i, a_1, a_2, \ldots, a_M), \; i = 1,2, \ldots, N \tag{A-3}$$

where $a = (a_1, a_2, \ldots, a_M)$. The only restriction on the function $f_i(a)$ is that the partial derivatives of the function with respect to the M parameters be continuous in all of the arguments.

This implies that $f_i(a)$ is a function that can be differentiated.

We assume that these partial derivatives exist at a point $\bar{a}$, and in some neighborhood about $\bar{a}$, which includes the point a. Let

$$a = \bar{a} + \Delta a \tag{A-4}$$

where $\bar{a} = (\bar{a}_1, \bar{a}_2, \ldots, \bar{a}_M)$ and $\Delta a = (\Delta a_1, \Delta a_2, \ldots, \Delta a_M)$.

If $f_i(a)$ can be differentiated at $\bar{a}$, then the differential at $\bar{a}$ is an approximation to $f_i(a) - f_i(\bar{a})$ and $f_i(a) - f_i(\bar{a}) = 0(\Delta a)(a \to \bar{a})$.

Thus,

$$f_i(a) - f_i(\bar{a}) = \sum_{j=1}^{j=M} \frac{\partial f_i(\bar{a})}{\partial a_j} \Delta a_j + E(\Delta a) \tag{A-5}$$

where $E(\Delta a) \to 0$ as $\Delta a \to 0$ for $i = 1, 2, \ldots, N$.

If the approximation $\bar{a}$ is close enough to the solution a, then the problem is considered solved when

$$\left| a_j - \bar{a}_j \right| = \left| \Delta a_j \right| \leq T, \; j = 1, 2, \ldots, M \tag{A-6}$$

where T = desired precision for the solution.

Formulation of Solution

We now derive the formulation for finding Δa. The solution a is then equal to $\bar{a} + \Delta a$.

Using equation (A-5), we form the overdetermined system of equations (N>M)

$$Y_i = f_i(a) = f_i(\bar{a}) + \sum_{j=1}^{j=M} \frac{\partial f_i(\bar{a})}{\partial a_j} \Delta a_j \tag{A-7}$$

for data points $i = 1, 2, \ldots, N$.

The system of equations used to find Δa becomes

$$\frac{\partial f_i(\bar{a})}{\partial a_1}\Delta a_1 + \frac{\partial f_i(\bar{a})}{\partial a_2}\Delta a_2 + \ldots + \frac{\partial f_i(\bar{a})}{\partial a_M}\Delta a_M = Y_i - f_i(\bar{a}) \qquad \text{(A-8)}$$

$(i = 1,2, \ldots, N)$.

The system of observational equations (A-8) can now be written in matrix form as given by

$$AX = Y \qquad \text{(A-9)}$$

where,

$$\Delta = \begin{pmatrix} \frac{\partial f_1(\bar{a})}{\partial a_1} & \frac{\partial f_1(\bar{a})}{\partial a_2} & \cdots & \frac{\partial f_1(\bar{a})}{\partial a_M} \\ \frac{\partial f_2(\bar{a})}{\partial a_1} & \frac{\partial f_2(\bar{a})}{\partial a_2} & \cdots & \frac{\partial f_2(\bar{a})}{\partial a_M} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial f_N(\bar{a})}{\partial a_1} & \frac{\partial f_N(\bar{a})}{\partial a_2} & \cdots & \frac{\partial f_N(\bar{a})}{\partial a_M} \end{pmatrix}$$

$$X = \begin{pmatrix} \Delta a_1 \\ \Delta a_2 \\ \cdot \\ \cdot \\ \cdot \\ \Delta a_M \end{pmatrix}$$

$$Y = \begin{pmatrix} y_1 - f_1(\bar{a}) \\ y_2 - f_2(\bar{a}) \\ \cdot \\ \cdot \\ \cdot \\ y_N - f_N(\bar{a}) \end{pmatrix}$$

The column matrix Y is called the residual matrix. Solving matrix equation (A-9) yields the normal equations in matrix form

$$A^T AX = A^T Y \tag{A-10}$$

If the residuals are to be weighted, we can include the weight matrix W where,

$$W = \begin{pmatrix} W_1 & & & & 0 \\ & W_2 & & & \\ & & \cdot & & \\ & & & \cdot & \\ & & & & \cdot \\ 0 & & & & W_N \end{pmatrix}, \tag{A-11}$$

Completing the solution to the matrix equation (A-10) and upon including the weight matrix, we have

$$X = (A^T WA)^{-1} A^T WY \tag{A-12}$$

X is the least-squares solution to the system of equations (A-8) with the weights included. Elements of the X matrix are now tested in absolute value against the tolerance T. If the tolerance test is satisfied, we are done and the least-square solution to equation (A-2) is given by

$$a_j = \bar{a}_j + \Delta a_j, \; j = 1,2, \ldots, M \tag{A-13}$$

Whenever the tolerance test fails, equation (A-13) gives the next approximation and the iteration process is repeated with matrix equation (A-12) until the tolerance test is satisfied.

Remarks

Once an acceptable solution has been found, it may be desirable to know how well the function fits the given data. Analysis for how well the solution fits can usually be made by examining the residuals for each observation.

The variances for the solution (a) can be found from the variance, covariance matrix.

If the variances and residuals are large, a different approximating function $f_i(a)$ may be tested.

When polynomials are used for testing, the residuals will drop off rapidly as the degree of the polynomial increases from one. Further increase in the degree of the polynomial will show little improvement of the residuals.

APPENDIX B

AN ALTERNATE METHOD FOR COMPUTING DENSITY

AN ALTERNATE METHOD FOR COMPUTING DENSITY

Since the procedure used to fit the observed densities provided little information as to why the correction term for altitudes below 3,500 ft improved the fit, an investigation was made using a sample set of data obtained from 25 sondes. The sondes were taken consecutively from the group that had been sorted according to season after the surface densities were arranged in numerical order. The median of the surface densities in the sample was equal to the U.S. Standard density at mean sea level. The sondes were released at station E during the spring season, 1200 hr G.m.t.

Separate least-squares fits were made to the pressure and temperature in the altitude range from 0 to 36,089 ft. No attempt was made to fit the temperature or pressure above 36,089-ft altitude.

The equation used to fit the pressure is similar to equation (1)

$$P = p_1 e^{(p_2 h)} + p_3 h \tag{B-1}$$

where

P is the pressure (mb)

h is the altitude (ft)

p_1, p_2, and p_3 are constants determined in the least-squares fit

The observed temperatures were first converted to virtual temperatures with the equation

$$TV = \frac{T}{1.0 - \frac{0.3783*RH*V}{P}} \tag{B-2}$$

where

TV is the virtual temperature (°K)

T is the observed temperature (°K)

RH is the observed relative humidity (dimensionless)

V is the saturation vapor pressure (mb)

P is the observed pressure (mb)

Several least-squares fits were made with the virtual temperature in the altitude range from 0 to 36,089 ft using polynomials that, in every case, produced large residuals below 5,000 ft. A big improvement was made by segmenting the data into three zones, 0 to 3,500, 3,501 to 6,000, and 6,001 to 36,089 ft. A one-degree polynomial least-squares fit was used in the two lower zones and a third-degree polynomial was used in the upper zone. The intersections of the equations are located at 3,731 and 5,270 ft which were used to define the boundaries of the zones.

The density was computed with the equation

$$\rho = P/(R*T) \tag{B-3}$$

where

ρ is the density (lb/ft^3)

P is the pressure determined by a least-squares fit (mb)

T is the temperature determined by a least-squares fit (°K)

R is a constant, 45.981610868

Computing the density in this manner made a small reduction in the mean of the residuals but no improvement in the standard deviation. While a single function fits the pressure from sea level to 36,089 ft, the nonlinearity in the temperature profile is quite apparent. The lapse rate in the temperature based on the least-squares fit from sea level to 3,731 ft is 2.60°C per 1,000 ft and 0.358°C per 1,000 ft from 3,731 to 5,270 ft using the intersections of the equations to define the zone boundaries. The average lapse rate based on the least-squares fit in the zone from 5,270 to 36,089 ft is 1.99°C per 1,000 ft. The latter value is in good agreement with the lapse rate of 1.98°C per 1,000 ft from sea level to 36,089 ft that was used to define the U.S. Standard atmosphere.

Profiles of the temperature and pressure obtained with the least-squares fit are shown in Figures B-1 and B-2, respectively. A profile of the density computed

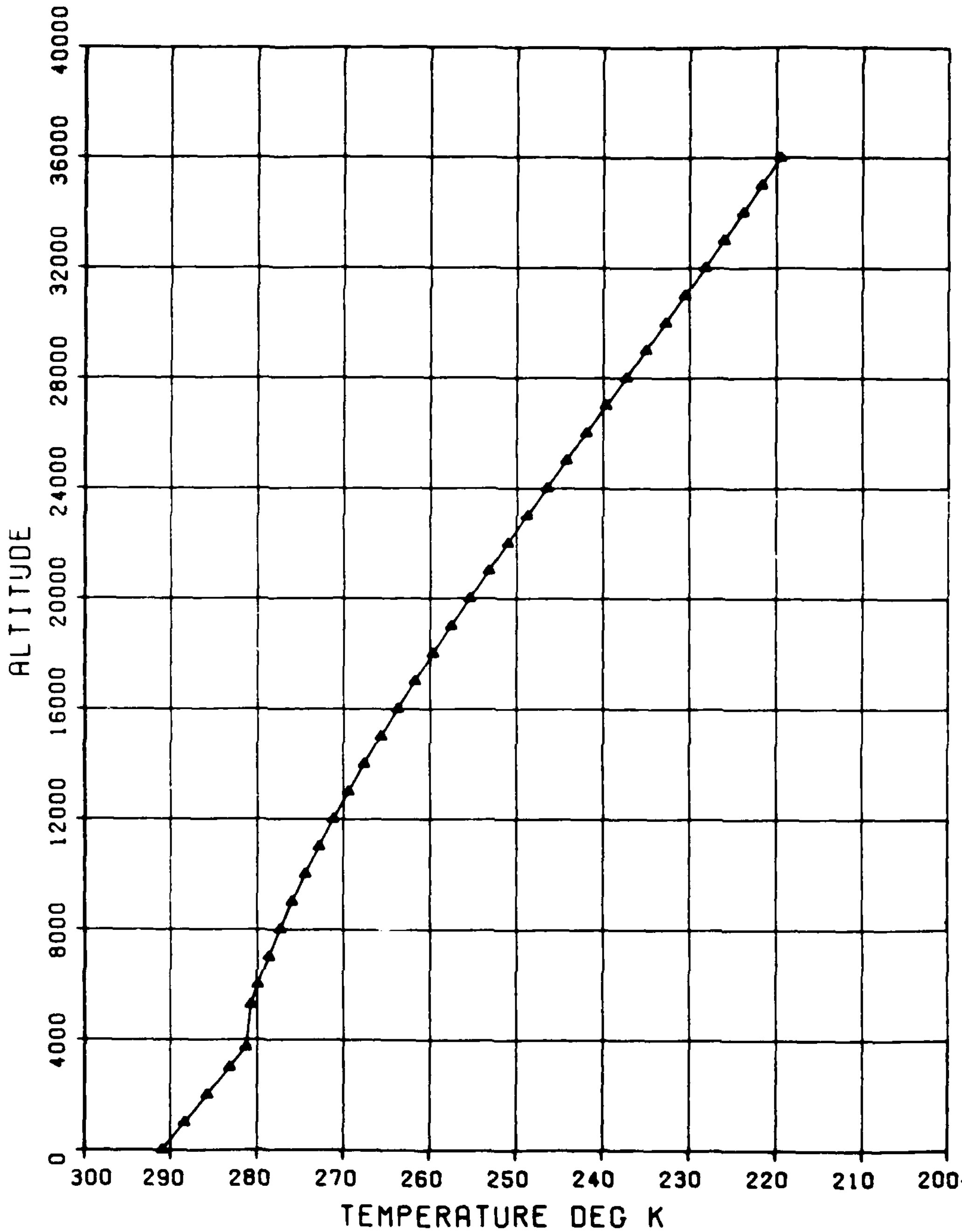

FIGURE B-1. STATION F SPRING 1200 hr G.m.t.
Temperature profile based on three least-squares fits, linear 0 - 3,500, linear 3,500 - 6,000, and third-degree polynomial 6,000 - 3,600 ft. The equations were spliced at 3,730 and 5,270 ft.

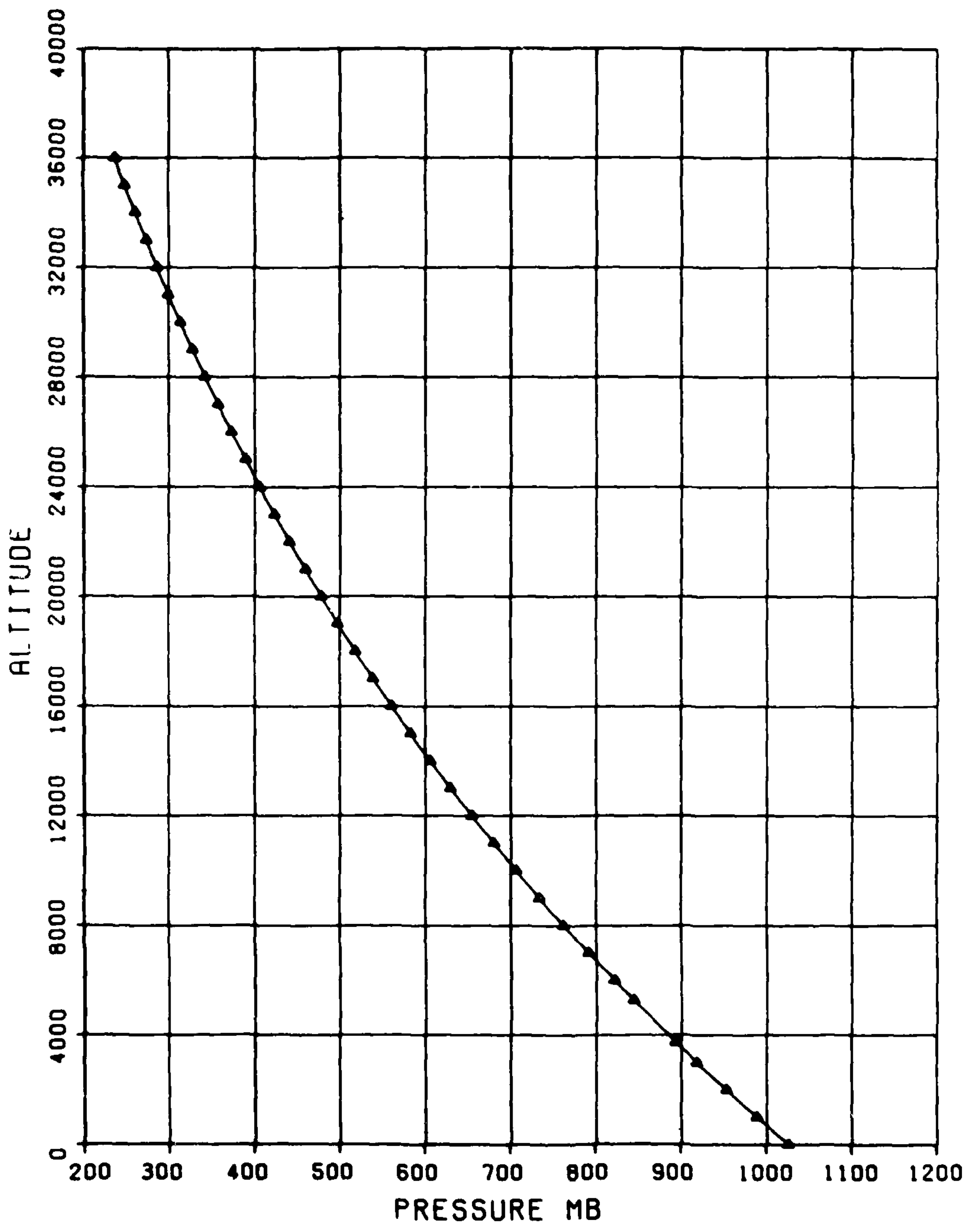

FIGURE B-2. STATION E 1200 hr G.m.t.
Pressure profile based on a least-squares fit with an exponential function.

with equation (7) is shown in Figure B-3. For comparison, Figure B-4 is a profile of the density computed with equations (1) and (3) where the coefficients were obtained by making a least-squares fit to the observed densities. Very little difference can be seen when curves of Figures B-3 and B-4 are superimposed.

From these results—(1) the small difference in the residuals between the two methods of calculating densities, and (2) indiscernible difference in the two curves obtained—it appears that there is no advantage in computing density from smoothed temperature and pressure data versus smoothed density data. It may be noted that the first method requires 11 undetermined constants, the latter only 4.

The method of making separate least-squares fits to the temperature and pressure does provide a much clearer explanation as to why the correction term in equation (3) improved the fit to the density. The reason is the large variations in the lapse rate of the temperature at the lower altitudes.

The equations used to fit the temperature are

Altitude (ft)	
0 - 3,500	Temperature = $a_0 + a\ h$
3,500 - 6,000	Temperature = $a_0' + a_1' h$
6,000 - 36,000	Temperature = $a_0'' + a_1'' h + a_2'' h^2 + a_3'' h^3$

where

temperature is the virtual temperature °K
h is the altitude in feet

The altitudes of intersections are 3,731 and 5,270 ft.

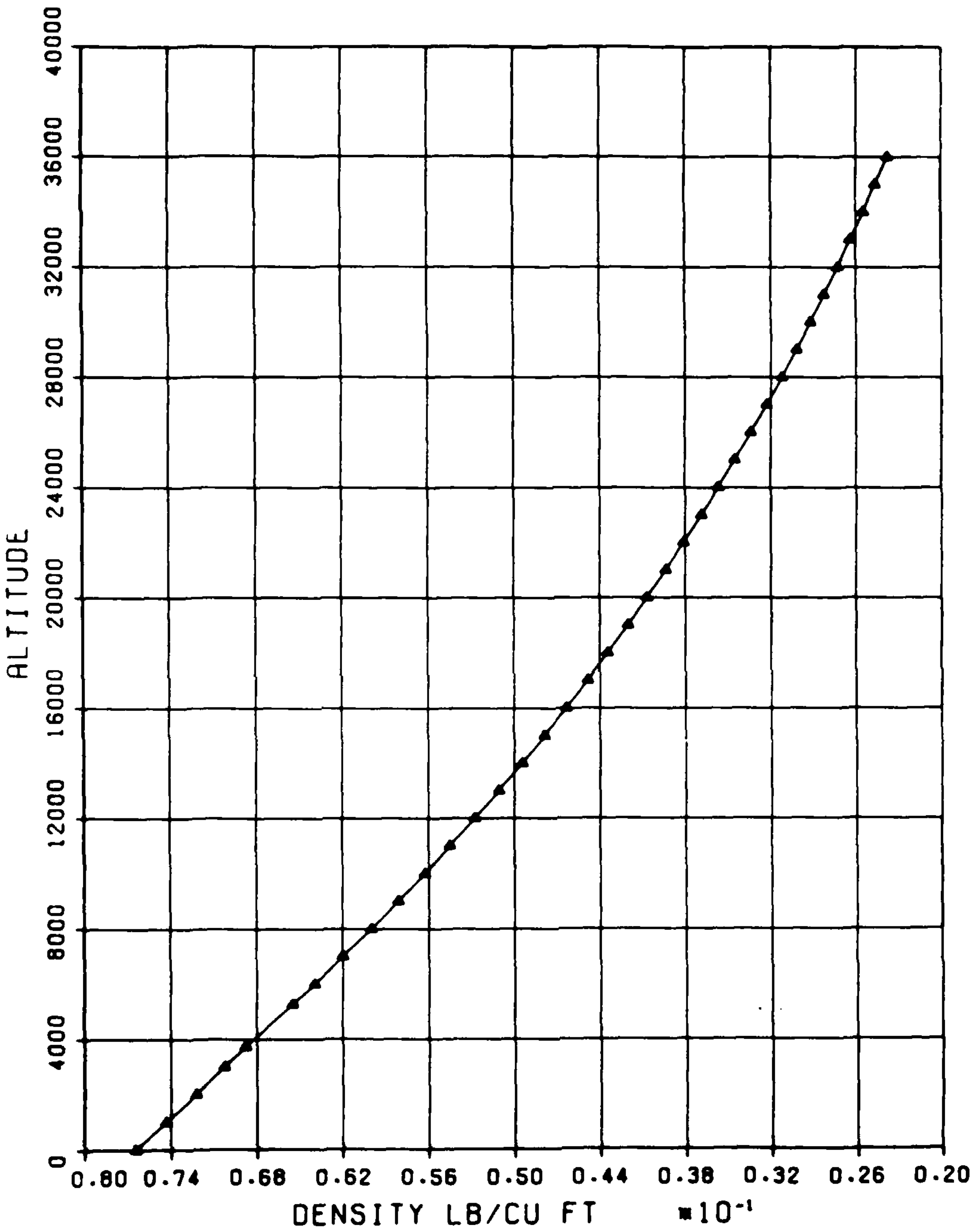

FIGURE B-3.
Density profile computed from the data of Figures B-1 and B-2.

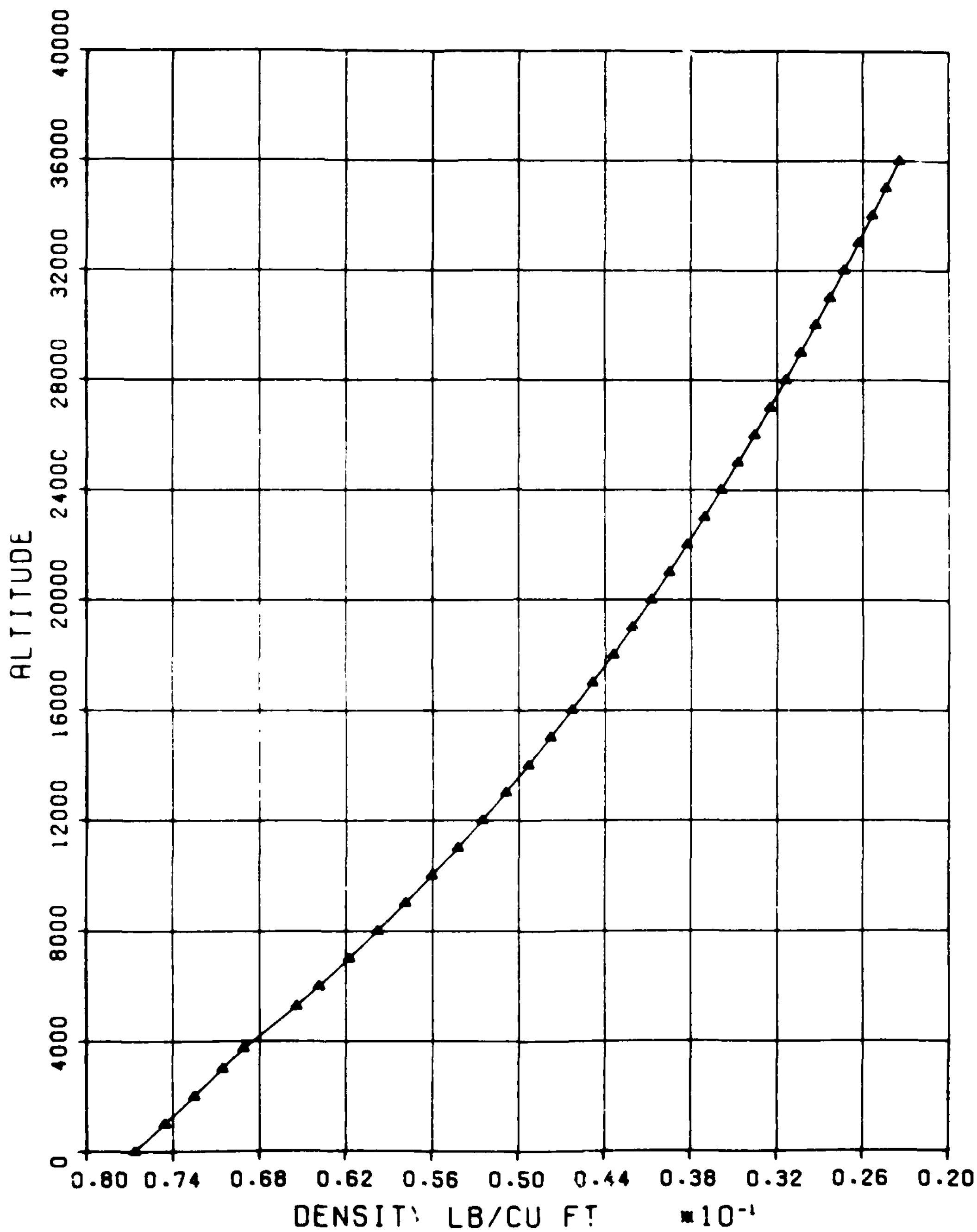

FIGURE B-4. STATION E SPRING 1200 hr G.m.t.
Density profile computed directly from a least-squares fit to the density.

The coefficients obtained in the least-squares fit are

a_0 = 0.29098019920169 E+3
a_1 = -0.26010921095663 E-2
a'_0 = 0.28261034232183 E+3
a'_1 = -0.35814511053088 E-3
a''_0 = 0.28474414363984 E+3
a''_1 = -0.42144325442356 E-3
a''_2 = -0.69303432938534 E-7
a''_3 = 0.85246672752231 E-12

The mean and standard deviations of the residuals divided by the computed values are

Altitude (ft)	Mean	Sigma	N
0 - 3,500	-0.00000002	0.00603867	98
3,500 - 6,000	0.00000000	0.01019354	76
6,000 - 36,000	-0.00000008	0.01654041	357
0 - 36,000	-0.00000362	0.01433263	531

N is the number of data points in the fit.

The temperature profile is shown in Figure B-1.

The equation used to fit the pressure is

$$P = c_1 * e^{(c_2 h)} + c_3 h$$

where

P is pressure in mb
h is the altitude in feet

The coefficients obtained in the least-squares fit are

$c_1 = 0.1025894426895$ E+4
$c_2 = -0.3512226501974$ E-4
$c_3 = -0.1469124958633$ E-2

The mean and standard deviation of the residuals divided by the computed values are

Altitude (ft)	Mean	Sigma	N
0 - 36,000	-0.00000270	0.01171363	531

N is the number of data points in the fit.

The pressure profile is shown in Figure B-2.

The density profile shown in Figure B-3 was computed with the equation

$$\rho = P/(R*t)$$

where

ρ is the density (lb/ft^3)
P is the pressure (mb)
T is the virtual temperature (°K)
R is a constant, 45.981610868

The mean and standard deviation of the residuals divided by the computed value are

Altitude (ft)	Mean	Sigma	N
0 - 36,000	0.00009937	0.01129087	531

The density profile shown in Figure B-4 for altitudes below 3,500 ft was computed with the equation,

$$\rho = c_1 e^{(c_2 h)} + c_3 h + (\rho_0 - c_1) \left| \frac{3500 - h}{3500} \right|$$

and for altitudes equal to or greater than 3,500 ft was computed with the equation

$$\rho = c_1 e^{(c_2 h)} + c_3 h$$

which is the same procedure described previously in the report. The coefficients used to create the profile are

$c_1 = 0.076640263730\ (\text{lb/ft}^3)$
$c_2 = -0.304780287061\ \text{E-4}\ (\text{ft}^{-1})$
$\rho_0 = 0.076474\ (\text{lb/ft}^3)$
$c_3 = -0.517405589378\ \text{E-7}\ (\text{lb/ft}^4)$

The mean and standard deviation of the residuals divided by the computed value are

Altitude (ft)	Mean	Sigma
0 - 36,000	0.00048651	0.01160715

APPENDIX C

COEFFICIENTS OBTAINED BY FITTING OBSERVED DENSITY

In this appendix, four lines of data appear for each group of sondes that were used in the least-squares fit.

Lines 1 and 2:

Item	Identification	Description
1	N	Number of data points that met tolerances
2	JE	Number of points used in fit
3	AMEAN	Mean of the residuals
4	SIGMA	Standard deviation of the residuals

Line 1 is for the altitude range from 0 to 36,089 ft, and Line 2 is for the altitude range 36,089 to 65,000 ft. The first five items in Lines 3 and 4 are coefficients C_1, C_2, and C_3 for equation (1), which were obtained by making a least-squares fit in the altitude range 3,500 to 36,089 ft, and coefficients C_4 and C_5 for equation (2), which were obtained by making a least-squares fit in the altitude range 36,089 to 65,000. The coefficients are listed in the order of their subscripts. The next item on Line 4 is the median of the surface densities of the sondes used in the fit. The last item is a counter and has no significance.

Data points refer to the individual altitudes where temperature, pressure, and humidity were recorded. The residuals were expressed as a ratio of the residual to the density obtained with the least-squares fit as stated previously. No data points were eliminated in the least-squares fit; but tolerances on the residuals were specified, and the number of points that met the tolerances were recorded. The tolerance used in the lower altitude region was 0.025, and in the higher region it was 0.150. A few tests were made to eliminate bad data points before the least-squares fit was performed.

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STATION E 00HR FOUR SEASONS

WINTER
   106 N        106 JE       .00009371 AMEAN      .00499973 SIGMA
    37 N         37 JE       .00053558 AMEAN      .01342884 SIGMA
  .075079281683  -.294862954960E-04  -.697033163821E-07  -.450764290603E-04
-.159550178886E-07     .07418000        1
   535 N        547 JE       .00004310 AMEAN      .01235709 SIGMA
   173 N        176 JE      -.00032082 AMEAN      .03395270 SIGMA
  .075748131856  -.305428508314E-04  -.518345657782E-07  -.409038381380E-04
-.449743040887E-07     .07494500        2
   547 N        553 JE       .00006191 AMEAN      .00879245 SIGMA
   198 N        198 JE      -.00192602 AMEAN      .02936409 SIGMA
  .076519989588  -.301148012167E-04  -.627915978676E-07  -.451529783579E-04
-.147871540870E-07     .07570900        3
   585 N        592 JE       .00021436 AMEAN      .00852413 SIGMA
   230 N        230 JE      -.00062556 AMEAN      .03150237 SIGMA
  .077508432763  -.305740514838E-04  -.500335521527E-07  -.457665151713E-04
-.980870348999E-08     .07647400        4
   624 N        632 JE       .00033378 AMEAN      .00948879 SIGMA
   240 N        240 JE       .00009101 AMEAN      .03334458 SIGMA
  .078881310762  -.323681211507E-04  -.199368741673E-07  -.459076070910E-04
-.162405407298E-07     .07723900        5
   106 N        107 JE       .00001313 AMEAN      .00984285 SIGMA
    46 N         46 JE      -.00164000 AMEAN      .02560609 SIGMA
  .080252489385  -.338561615734E-04   .560937162076E-08  -.507730626667E-04
 .150172841422E-07     .07800300        6

SPRING
    85 N         85 JE      -.00012323 AMEAN      .00419959 SIGMA
    33 N         33 JE      -.00032452 AMEAN      .03489420 SIGMA
  .074353885262  -.284235206192E-04  -.941032720434E-07  -.380570178375E-04
-.727382338584E-07     .07418000        7
   716 N        721 JE       .00013955 AMEAN      .00629754 SIGMA
   271 N        271 JE       .00186141 AMEAN      .03009369 SIGMA
  .075733087556  -.300418665094E-04  -.551187072110E-07  -.394703344566E-04
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```
-.625403819063E-07      .07494500        8
     594 N        605 JE       .00023908 AMEAN       .01023382 SIGMA
     220 N        220 JE       .00131510 AMEAN       .02999432 SIGMA
   .076742754647  -.306838920088E-04  -.505840324145E-07  -.421123394778E-04
-.423100572783E-07      .07570900        9
     529 N        535 JE       .00046346 AMEAN       .00960208 SIGMA
     205 N        205 JE      -.00008578 AMEAN       .03557140 SIGMA
   .077239352033  -.312365997541E-04  -.342772620491E-07  -.428283018612E-04
-.368989089084E-07      .07647400        10
     115 N        117 JE       .00084830 AMEAN       .01277639 SIGMA
      44 N         44 JE       .00242485 AMEAN       .02579073 SIGMA
   .078432436906  -.319666630560E-04  -.245952632508E-07  -.465006812171E-04
-.126913193672E-07      .07723900        11

    SUMMER
      39 N         39 JE       .00003057 AMEAN       .00442968 SIGMA
      13 N         13 JE       .00188364 AMEAN       .01798935 SIGMA
   .074002617454  -.299262474105E-04  -.455109721199E-07  -.306666378990E-04
-.135069282391E-06      .07265000        12
     557 N        557 JE       .00005280 AMEAN       .00495224 SIGMA
     172 N        172 JE       .00196325 AMEAN       .01876588 SIGMA
   .074411095244  -.294635397582E-04  -.579634937853E-07  -.329739352781E-04
-.114884418235E-06      .07341500        13
     582 N        583 JE       .00025465 AMEAN       .00554850 SIGMA
     167 N        167 JE       .00180320 AMEAN       .02114770 SIGMA
   .075116341423  -.293381346612E-04  -.643063682866E-07  -.346008755020E-04
-.100301112936E-06      .07418000        14
     601 N        601 JE       .00008318 AMEAN       .00651381 SIGMA
     187 N        187 JE       .00170748 AMEAN       .02126472 SIGMA
   .076057514114  -.302017801983E-04  -.508650826689E-07  -.356795725945E-04
-.888873039486E-07      .07494500        15
      65 N         66 JE       .00044599 AMEAN       .00916918 SIGMA
      33 N         33 JE       .00145388 AMEAN       .02100466 SIGMA
   .076583644671  -.324380267945E-04   .251304420554E-08  -.344656943297E-04
-.103389959675E-06      .07570900        16
```

```
FALL
     76 N        76 JE      .00032131 AMEAN      .00639478 SIGMA
     30 N        30 JE      .00088378 AMEAN      .03100741 SIGMA
   .074885189662  -.297345986104E-04  -.570098172919E-07  -.368081504810E-04
-.817375737339E-07      .07341500       17
    552 N       557 JE      .00031228 AMEAN      .00706654 SIGMA
    185 N       185 JE      .00001647 AMEAN      .03334804 SIGMA
   .075059277710  -.296044770631E-04  -.623120720704E-07  -.366529441989E-04
-.818355014763E-07      .07418000       18
    566 N       568 JE      .00016250 AMEAN      .00716179 SIGMA
    219 N       219 JE      .00047250 AMEAN      .03144311 SIGMA
   .075989481796  -.306654221840E-04  -.384741248165E-07  -.396086919246E-04
-.606548996052E-07      .07494500       19
    579 N       584 JE      .00020431 AMEAN      .00897739 SIGMA
    231 N       231 JE     -.00060221 AMEAN      .02636899 SIGMA
   .077258445293  -.315266459161E-04  -.259998924279E-07  -.440922788535E-04
-.260602884661E-07      .07570900       20
    124 N       124 JE     -.00023166 AMEAN      .00855050 SIGMA
     41 N        41 JE     -.00215124 AMEAN      .02388429 SIGMA
   .078307086422  -.317086362801E-04  -.337162163010E-07  -.486503319257E-04
-.169464336075E-08      .07647400       21

STATION E 00HR GMT SEASONS COMBINED
     55 N        55 JE     -.00013503 AMEAN      .00438076 SIGMA
     21 N        21 JE      .00153047 AMEAN      .01751126 SIGMA
   .073916454338  -.297183718810E-04  -.526446694885E-07  -.288613372840E-04
-.153449666026E-06      .07265000        1
    542 N       543 JE      .00007340 AMEAN      .00521675 SIGMA
    168 N       168 JE      .00182577 AMEAN      .02135036 SIGMA
   .074461986973  -.294345939445E-04  -.586052812264E-07  -.341636027919E-04
-.103945419144E-06      .07341500        2
    561 N       561 JE      .00034351 AMEAN      .00611733 SIGMA
    174 N       174 JE      .00078476 AMEAN      .02222567 SIGMA
   .075164029585  -.296631277419E-04  -.573271511476E-07  -.366071002444E-04
-.798583058256E-07      .07418000        3
    629 N       633 JE      .00006990 AMEAN      .00743407 SIGMA
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```
      238 N         239 JE       .00077494 AMEAN       .03043555 SIGMA
     .076003913198  -.305940735172E-04  -.418309714857E-07  -.484390289412E-04
-.508645843921E-07       .07494500         4
      539 N         550 JE       .00024759 AMEAN       .01056239 SIGMA
      181 N         181 JE       .00111095 AMEAN       .02725811 SIGMA
     .076678434996  -.308753218587E-04  -.446318169070E-07  -.421188254661E-04
-.406748569099E-07       .07570900         5
      585 N         592 JE       .00015789 AMEAN       .00839561 SIGMA
      226 N         226 JE      -.00095049 AMEAN       .03406700 SIGMA
     .077586192104  -.311540064632E-04  -.422547625365E-07  -.450706183171E-04
-.180519540787E-07       .07647400         6
      548 N         555 JE       .00046953 AMEAN       .01040882 SIGMA
      225 N         225 JE       .00093183 AMEAN       .03213343 SIGMA
     .078649231085  -.323476217940E-04  -.168946267275E-07  -.457746168953E-04
-.188835761990E-07       .07723900         7
      155 N         157 JE       .00015486 AMEAN       .01001072 SIGMA
       70 N          70 JE      -.00117266 AMEAN       .02554801 SIGMA
     .080008865235  -.332939606239E-04  -.482455101442E-08  -.507021981509E-04
 .138064671447E-07       .07800300         8
       31 N          40 JE      -.00142227 AMEAN       .02145617 SIGMA
       16 N          16 JE       .00136873 AMEAN       .01188424 SIGMA
     .080111899019  -.346798589829E-04   .402026625526E-07  -.490576876369E-04
-.570790632045E-08       .07876800         9
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STATION E 12HR FOUR SEASONS

WINTER

```
      155 N         155 JE      -.00008078 AMEAN       .00489720 SIGMA
       37 N          37 JE       .00023310 AMEAN       .02602642 SIGMA
     .075030877430  -.300326914880E-04  -.550372354609E-07  -.395274000044E-04
-.543206237525E-07       .07418000         1
      545 N         557 JE      -.00010871 AMEAN       .01084876 SIGMA
      218 N         218 JE      -.00065341 AMEAN       .03205415 SIGMA
     .076197196680  -.303223535418E-04  -.601704522812E-07  -.459187309579E-04
-.588017794425E-08       .07494500         2
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     591 N        594 JE      .00011056 AMEAN      .00709901 SIGMA
     249 N        249 JE     -.00085312 AMEAN      .02425483 SIGMA
   .077022282557  -.310423451067E-04  -.428056661647E-07  -.461343999269E-04
-.795508850802E-08       .07570900         3
     335 N        339 JE      .00026528 AMEAN      .00999285 SIGMA
     146 N        146 JE      .00002409 AMEAN      .02278905 SIGMA
   .077820361702  -.314542580480E-04  -.347222888008E-07  -.432410190256E-04
-.332274942909E-07       .07647400         4
     611 N        617 JE      .00029613 AMEAN      .00906797 SIGMA
     254 N        254 JE     -.00133092 AMEAN      .02851303 SIGMA
   .079158387943  -.330580221397E-04  -.215356284127E-08  -.483625659055E-04
-.807231527157E-09       .07723900         5

  SPRING
     219 N        219 JE     -.00005360 AMEAN      .00389571 SIGMA
      95 N         95 JE      .00121376 AMEAN      .03599471 SIGMA
   .075123190148  -.295923492901E-04  -.685606999806E-07  -.415998156953E-04
-.406396599472E-07       .07418000         6
     572 N        576 JE      .00011338 AMEAN      .00738243 SIGMA
     240 N        240 JE      .00083964 AMEAN      .03431977 SIGMA
   .075830354575  -.302078603356E-04  -.543715278413E-07  -.402946907470E-04
-.534843663219E-07       .07494500         7
     524 N        528 JE      .00039618 AMEAN      .01730689 SIGMA
     214 N        214 JE      .00163039 AMEAN      .02414344 SIGMA
   .076640263730  -.304780287061E-04  -.517405589378E-07  -.410525537453E-04
-.484707804362E-07       .07570900         8
     522 N        531 JE      .00048651 AMEAN      .01160715 SIGMA
     253 N        255 JE      .00024623 AMEAN      .02951284 SIGMA
   .077487922568  -.313676919544E-04  -.353021223364E-07  -.438039057253E-04
-.292856394714E-07       .07647400         9
     101 N        102 JE      .00157844 AMEAN      .01217757 SIGMA
      27 N         27 JE      .00001065 AMEAN      .01501577 SIGMA
   .078733576672  -.330111444168E-04   .166763630685E-08  -.474730682042E-04
-.844893833634E-08       .07723900        10

  SUMMER
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     562 N        562 JE       .00003631 AMEAN       .00576280 SIGMA
     242 N        242 JE       .00187801 AMEAN       .02170284 SIGMA
    .074541372461  -.296703645956E-04  -.554732911082E-07  -.335399439230E-04
-.109059773373E-06       .07341500        11
     532 N        532 JE       .00029180 AMEAN       .00516922 SIGMA
     171 N        171 JE       .00100929 AMEAN       .01845597 SIGMA
    .075214489043  -.294920244574E-04  -.616491043396E-07  -.361677762944E-04
-.840571249790E-07       .07418000        12
     504 N        507 JE       .00030070 AMEAN       .02256684 SIGMA
     196 N        196 JE       .00189725 AMEAN       .02122023 SIGMA
    .075858349635  -.299037346719E-04  -.568828999155E-07  -.353067485094E-04
-.940225706960E-07       .07494500        13

  FALL
     101 N        103 JE       .00036658 AMEAN       .01249749 SIGMA
      28 N         28 JE       .00178426 AMEAN       .01635500 SIGMA
    .075386975714  -.316199839816E-04  -.126806169228E-07  -.382494516627E-04
-.716522639671E-07       .07341500        14
     584 N        585 JE       .00024980 AMEAN       .00557367 SIGMA
     257 N        257 JE       .00105104 AMEAN       .02811453 SIGMA
    .075244152328  -.304716383621E-04  -.390097796857E-07  -.364552200297E-04
-.862710989754E-07       .07418000        15
     500 N        503 JE       .00028466 AMEAN       .00855190 SIGMA
     198 N        198 JE       .00073576 AMEAN       .02917977 SIGMA
    .075879139253  -.306557368546E-04  -.391173189122E-07  -.377710286554E-04
-.744068388949E-07       .07494500        16
     537 N        541 JE       .00035236 AMEAN       .01068197 SIGKA
     225 N        225 JE      -.00026563 AMEAN       .02507368 SIGMA
    .077099881194  -.309308827165E-04  -.463637399804E-07  -.407976746180E-04
-.502856873135E-07       .07570900        17
     189 N        192 JE      -.00001691 AMEAN       .01039020 SIGMA
      81 N         81 JE       .00041722 AMEAN       .03495259 SIGMA
    .078636487486  -.333117573130E-04   .306983969321E-08  -.434169559436E-04
-.392624149192E-07       .07647400        18

  STATION E 12HR GMT SEASONS COMBINED
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```
    83 N         83 JE     -.00021132 AMEAN      .00588070 SIGMA
    40 N         40 JE      .00209744 AMEAN      .02342494 SIGMA
  .074046594670  -.297621698012E-04  -.561603633550E-07  -.304381710796E-04
-.132484417091E-06     .07265000        1
   564 N        566 JE      .00007565 AMEAN      .00749577 SIGMA
   229 N        229 JE      .00177311 AMEAN      .02145995 SIGMA
  .074764931991  -.300376322102E-04  -.475062967547E-07  -.340757002530E-04
-.104346667678E-06     .07341500        2
   559 N        559 JE      .00019089 AMEAN      .00628409 SIGMA
   226 N        227 JE      .00093570 AMEAN      .03109516 SIGMA
  .075164001806  -.297553589230E-04  -.575532631951E-07  -.378655930475E-04
-.718505014332E-07     .07418000        3
   546 N        548 JE      .00026285 AMEAN      .00781521 SIGMA
   175 N        175 JE     -.00023137 AMEAN      .03879552 SIGMA
  .075999033383  -.305589095068E-04  -.459294593779E-07  -.389371012515E-04
-.640440113895E-07     .07494500        4
   549 N        553 JE      .00033323 AMEAN      .00928353 SIGMA
   229 N        229 JE      .00091878 AMEAN      .02443316 SIGMA
  .076847976664  -.308670522879E-04  -.448103227586E-07  -.423018423799E-04
-.389831276971E-07     .07570900        5
   539 N        549 JE      .00057035 AMEAN      .01217471 SIGMA
   256 N        258 JE      .00015215 AMEAN      .03158384 SIGMA
  .077741410559  -.314122542703E-04  -.384551540687E-07  -.425026724634E-04
-.384231841904E-07     .07647400        6
   266 N        268 JE      .00014534 AMEAN      .00842401 SIGMA
    97 N         97 JE     -.00210771 AMEAN      .02880938 SIGMA
  .079161559258  -.332958045749E-04  -.372624763272E-09  -.489518104223E-04
 .688395383325E-08     .07723900        7
   123 N        124 JE     -.00022082 AMEAN      .00996760 SIGMA
    75 N         75 JE     -.00243365 AMEAN      .02582058 SIGMA
  .080305994829  -.346243599295E-04   .248231111476E-07  -.513815102647E-04
 .178521124119E-07     .07800300        8
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STATION V 00HR FOUR SEASONS

WINTER
      83 N          83 JE       .00003488 AMEAN       .00867984 SIGMA
      27 N          27 JE      -.00009238 AMEAN       .01895347 SIGMA
    .074525310138  -.294218657930E-04  -.889947170139E-07  -.357431352087E-04
-.759650134623E-07       .07418000          1
     429 N         468 JE       .00021326 AMEAN       .01663872 SIGMA
     165 N         165 JE      -.00054370 AMEAN       .02743251 SIGMA
    .075840253696  -.287994758650E-04  -.126614671712E-06  -.377219365718E-04
-.589023875055E-07       .07494500          2
     521 N         579 JE       .00017659 AMEAN       .01462575 SIGMA
     223 N         223 JE       .00087728 AMEAN       .03009421 SIGMA
    .076734353922  -.300731732332E-04  -.882602213997E-07  -.401466385334E-04
-.475488083265E-07       .07570900          3
     485 N         537 JE       .00021426 AMEAN       .01723880 SIGMA
     173 N         173 JE      -.00154323 AMEAN       .02983285 SIGMA
    .077994143861  -.302072669337E-04  -.108472239971E-06  -.375602452599E-04
-.615770739966E-07       .07647400          4
     484 N         547 JE       .00016713 AMEAN       .01588830 SIGMA
     179 N         179 JE      -.00004863 AMEAN       .03214428 SIGMA
    .079468035421  -.319857227511E-04  -.684759761459E-07  -.432629505650E-04
-.263435881045E-07       .07723900          5
     121 N         128 JE       .00000446 AMEAN       .01377598 SIGMA
      39 N          39 JE       .00018888 AMEAN       .02888136 SIGMA
    .080502548356  -.326935671221E-04  -.623200361131E-07  -.438780590958E-04
-.202332989177E-07       .07800300          6

SPRING
     331 N         331 JE      -.00021690 AMEAN       .00665890 SIGMA
     135 N         135 JE       .00179898 AMEAN       .02282032 SIGMA
    .074453385033  -.305400405068E-04  -.389115214548E-07  -.293581924203E-04
-.145083536797E-06       .07418000          7
     554 N         554 JE       .00022910 AMEAN       .00674795 SIGMA
     224 N         224 JE       .00089275 AMEAN       .02677927 SIGMA
    .075297620599  -.307737336106E-04  -.381636865587E-07  -.342898622142E-04
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-.992698633533E-07       .07494500         8
     496 N        499 JE       .00069663 AMEAN       .00841648 SIGMA
     233 N        233 JE       .00117567 AMEAN       .02706887 SIGMA
    .076375355053  -.319260819310E-04  -.151112583285E-07  -.365229419267E-04
-.826885916713E-07       .07570900         9
     486 N        491 JE       .00079095 AMEAN       .01025155 SIGMA
     183 N        183 JE       .00025417 AMEAN       .02994907 SIGMA
    .077403076367  -.319212861014E-04  -.265096729784E-07  -.420671940430E-04
-.382377037819E-07       .07647400         10
     450 N        479 JE       .00069546 AMEAN       .01556209 SIGMA
     218 N        218 JE      -.00075293 AMEAN       .03164796 SIGMA
    .078506446170  -.329034979386E-04  -.121449057635E-07  -.425025201965E-04
-.344639618665E-07       .07723900         11
      77 N         80 JE       .00111974 AMEAN       .01556016 SIGMA
      32 N         32 JE      -.00045779 AMEAN       .03555065 SIGMA
    .080158620606  -.338559601999E-04  -.791389394562E-08  -.437431445873E-04
-.250120355242E-07       .07800300         12

  SUMMER
     257 N        258 JE       .00049459 AMEAN       .00518061 SIGMA
     130 N        130 JE       .00046939 AMEAN       .01562624 SIGMA
    .073834695782  -.299075280005E-04  -.469988143453E-07  -.293497892563E-04
-.146006104824E-06       .07265000         13
     537 N        537 JE       .00041293 AMEAN       .00536209 SIGMA
     246 N        246 JE       .00111684 AMEAN       .01991504 SIGMA
    .074398672355  -.298644556726E-04  -.509673466174E-07  -.303159600471E-04
-.137255272276E-06       .07341500         14
     474 N        484 JE       .00011263 AMEAN       .00864456 SIGMA
     204 N        204 JE       .00108644 AMEAN       .02436276 SIGMA
    .074653295496  -.303068679490E-04  -.423049486968E-07  -.381955326060E-04
-.140801919785E-06       .07418000         15
     223 N        223 JE       .00050054 AMEAN       .00726032 SIGMA
      81 N         81 JE       .00155510 AMEAN       .02114007 SIGMA
    .075490897693  -.312039232458E-04  -.287569972084E-07  -.295621761640E-04
-.149857332670E-06       .07494500         16
      79 N         79 JE       .00110488 AMEAN       .00704344 SIGMA
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    28 N        28 JE      .00220634 AMEAN      .02351338 SIGMA
   .076452825232  -.322150969424E-04  -.105782531427E-07  -.305438953662E-04
-.143182030283E-06      .07570900         17

 FALL
    63 N        66 JE      .00089662 AMEAN      .01184406 SIGMA
    29 N        29 JE      .00072779 AMEAN      .03187706 SIGMA
   .074529973823  -.298053874036E-04  -.675775141757E-07  -.323187648035E-04
-.110701869053E-06      .07265000         18
   473 N       483 JE      .00057329 AMEAN      .01183236 SIGMA
   202 N       202 JE      .00025734 AMEAN      .02593735 SIGMA
   .074470020403  -.303310851642E-04  -.424962721334E-07  -.326282530301E-04
-.108744669638E-06      .07341500         19
   558 N       575 JE      .00042831 AMEAN      .00967863 SIGMA
   252 N       252 JE      .00096085 AMEAN      .02890084 SIGMA
   .075196633828  -.307456039839E-04  -.387826647628E-07  -.318198270188E-04
-.118934036614E-06      .07418000         20
   486 N       508 JE      .00041327 AMEAN      .01128679 SIGMA
   196 N       197 JE      .00034275 AMEAN      .03069611 SIGMA
   .076475725405  -.313048960551E-04  -.394490967851E-07  -.351120856390E-04
-.896076790981E-07      .07494500         21
   513 N       532 JE      .00029409 AMEAN      .01134144 SIGMA
   188 N       188 JE      .00070575 AMEAN      .02676650 SIGMA
   .077303846377  -.310324373275E-04  -.565250578697E-07  -.364050371350E-04
-.770845504180E-07      .07570900         22
   233 N       249 JE      .00055884 AMEAN      .01366360 SIGMA
   100 N       101 JE      .00136592 AMEAN      .03400048 SIGMA
   .078009883524  -.307006562986E-04  -.808890673004E-07  -.381294677370E-04
-.597978694152E-07      .07647400         23

 STATION V 00HR GMT SEASONS COMBINED
   224 N       227 JE      .00066458 AMEAN      .00693522 SIGMA
   111 N       111 JE      .00104679 AMEAN      .02385175 SIGMA
   .073742726211  -.295084259006E-04  -.509910915601E-07  -.294580426772E-04
-.141212329378E-06      .07265000          1
   548 N       550 JE      .00038254 AMEAN      .00960745 SIGMA
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       250 N       250 JE      .00096174 AMEAN      .01855027 SIGMA
     .074285321915  -.296404591366E-04  -.552296924611E-07  -.303731981129E-04
 -.137345456879E-06       .07341500           2
       463 N       467 JE      .00018092 AMEAN      .00891575 SIGMA
       192 N       192 JE      .00112189 AMEAN      .02788104 SIGMA
     .074568129060  -.302857871537E-04  -.433444133352E-07  -.311252385886E-04
 -.129308750209E-06       .07418000           3
       493 N       497 JE      .00024288 AMEAN      .00947701 SIGMA
       216 N       221 JE     -.00062345 AMEAN      .04046570 SIGMA
     .075483116503  -.307409426338E-04  -.445518593752E-07  -.348111024533E-04
 -.951991274713E-07       .07494500           4
       477 N       495 JE      .00037819 AMEAN      .01217347 SIGMA
       204 N       205 JE      .00052841 AMEAN      .03139579 SIGMA
     .076819784822  -.310082842379E-04  -.537445699170E-07  -.367416884154E-04
 -.756635078414E-07       .07570900           5
       503 N       543 JE      .00045160 AMEAN      .01605234 SIGMA
       184 N       184 JE     -.00065091 AMEAN      .03406634 SIGMA
     .377727660911  -.306318303699E-04  -.841716006234E-07  -.382500798133E-04
 -.577647836360E-07       .07647400           6
       446 N       512 JE      .00028312 AMEAN      .01638828 SIGMA
       187 N       187 JE     -.00104431 AMEAN      .04069482 SIGMA
     .079205506138  -.322837087475E-04  -.484228059255E-07  -.443498196073E-04
 -.207590944958E-07       .07723900           7
       186 N       209 JE      .00046880 AMEAN      .01594894 SIGMA
        64 N        64 JE      .00042416 AMEAN      .03376212 SIGMA
     .080135279840  -.333287227749E-04  -.314208332089E-07  -.417557878261E-04
 -.398084367770E-07       .07800300           8

   STATION V 12HR FOUR SEASONS

   WINTER
       285 N       317 JE      .00030677 AMEAN      .01389208 SIGMA
       102 N       102 JE      .00101340 AMEAN      .02943109 SIGMA
     .075624332070  -.286980828583E-04  -.115006992028E-06  -.366286477706E-04
 -.787878194283E-07       .07494500           1
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     519 N        576 JE       .00020244 AMEAN       .01463718 SIGMA
     193 N        193 JE       .00103998 AMEAN       .02591571 SIGMA
    .076592440859  -.290187241174E-04  -.123699243857E-06  -.394272586162E-04
-.503765266151E-07       .07570900         2
     509 N        579 JE       .00004082 AMEAN       .01632378 SIGMA
     152 N        152 JE      -.00211796 AMEAN       .02925557 SIGMA
    .078091441643  -.303107641353E-04  -.109506561549E-06  -.391140301400E-04
-.525701389808E-07       .07647400         3
     570 N        629 JE       .00003183 AMEAN       .01599494 SIGMA
     195 N        195 JE       .00041099 AMEAN       .03893443 SIGMA
    .079076168276  -.305858446441E-04  -.117209879059E-06  -.370609323949E-04
-.633789232041E-07       .07723900         4
     182 N        204 JE      -.00006701 AMEAN       .01797914 SIGMA
      94 N         94 JE      -.00157198 AMEAN       .03135920 SIGMA
    .079311925241  -.320815241337E-04  -.558804140712E-07  -.457126158970E-04
-.131787896224E-07       .07800300         5

  SPRING
     300 N        303 JE      -.00021213 AMEAN       .00930673 SIGMA
      85 N         85 JE       .00157153 AMEAN       .02060211 SIGMA
    .074230130565  -.298791450222E-04  -.534506280813E-07  -.277019360474E-04
-.161386253839E-06       .07418000         6
     543 N        548 JE       .00005107 AMEAN       .00783155 SIGMA
     206 N        206 JE       .00009827 AMEAN       .03336226 SIGMA
    .075190085455  -.305547370120E-04  -.419669367707E-07  -.341220992138E-04
-.101092077309E-06       .07494500         7
     487 N        496 JE      -.00008614 AMEAN       .00936743 SIGMA
     164 N        164 JE       .00087403 AMEAN       .02716496 SIGMA
    .076059077338  -.309897347071E-04  -.382261335649E-07  -.351303490689E-04
-.969264363965E-07       .07570900         8
     526 N        533 JE       .00023203 AMEAN       .00942645 SIGMA
     218 N        218 JE       .00054277 AMEAN       .02378035 SIGMA
    .076812831882  -.314493026731E-04  -.304295412045E-07  -.390781476125E-04
-.584487887916E-07       .07647400         9
     542 N        565 JE       .00063635 AMEAN       .01231613 SIGMA
     221 N        221 JE      -.00032297 AMEAN       .02670419 SIGMA
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      .078348772632  -.329248708264E-04  -.965242606402E-08  -.398181269436E-04
  -.553552965304E-07       .07723900        10
      143 N        159 JE      .00062537 AMEAN      .01714368 SIGMA
       51 N         51 JE     -.00224066 AMEAN      .02688810 SIGMA
      .079480793954  -.331029840753E-04  -.228922596025E-07  -.390172357285E-04
  -.588398704511E-07       .07800300        11

    SUMMER
      126 N        127 JE      .00023698 AMEAN      .00413199 SIGMA
       38 N         38 JE      .00105025 AMEAN      .01445720 SIGMA
      .073355349458  -.292781907647E-04  -.600468763146E-07  -.289717760913E-04
  -.154414768888E-06       .07265000        12
      604 N        607 JE      .00030155 AMEAN      .00915839 SIGMA
      216 N        216 JE      .00168949 AMEAN      .02121952 SIGMA
      .074245712057  -.297030779395E-04  -.545794300023E-07  -.296797941819E-04
  -.144049673135E-06       .07341500        13
      547 N        548 JE      .00005213 AMEAN      .00795139 SIGMA
      176 N        176 JE      .00167458 AMEAN      .02182120 SIGMA
      .074593316277  -.302018333619E-04  -.438049492357E-07  -.289880035472E-04
  -.153736994234E-06       .07418000        14
      195 N        196 JE     -.00023128 AMEAN      .00884931 SIGMA
       46 N         46 JE      .00218660 AMEAN      .02346876 SIGMA
      .075784831336  -.312511926059E-04  -.307202293925E-07  -.298732976122E-04
  -.142391587713E-06       .07494500        15

    FALL
      220 N        221 JE      .00037170 AMEAN      .00686836 SIGMA
       72 N         72 JE     -.00053397 AMEAN      .02929456 SIGMA
      .074150371571  -.298353277870E-04  -.522245911671E-07  -.315744162615E-04
  -.120286746520E-06       .07341500        15
      584 N        593 JE      .00029615 AMEAN      .00811517 SIGMA
      198 N        198 JE      .00029319 AMEAN      .01879306 SIGMA
      .074767015987  -.303353314597E-04  -.416035915692E-07  -.322001929381E-04
  -.114552776729E-06       .07418000        17
      550 N        566 JE      .00008180 AMEAN      .01145630 SIGMA
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     171 N        172 JE     -.00099932 AMEAN      .03163180 SIGMA
    .076526226097  -.315506128979E-04   -.328688028215E-07   -.336927796765E-04
-.101684380686E-06     .07494500        18
     466 N        505 JE     -.00028139 AMEAN      .01887042 SIGMA
     170 N        170 JE      .00052249 AMEAN      .02430470 SIGMA
    .077353337808  -.318795221812E-04   -.295590629490E-07   -.382940424519E-04
-.656092084431E-07     .07570900        19
     155 N        166 JE      .00013526 AMEAN      .01594979 SIGMA
      74 N         74 JE     -.00215964 AMEAN      .03295328 SIGMA
    .078080812927  -.310313464471E-04   -.653790474402E-07   -.417386199789E-04
-.321056579520E-07     .07647400        20

  STATION V 12HR GMT SEASONS COMBINED
     196 N        199 JE      .00014989 AMEAN      .00881123 SIGMA
      52 N         52 JE     -.00130513 AMEAN      .03787252 SIGMA
    .073916084886  -.299941326198E-04   -.512751042208E-07   -.326702082618E-04
-.110910166248E-06     .07265000         1
     606 N        608 JE      .00005083 AMEAN      .00553411 SIGMA
     223 N        223 JE      .00145157 AMEAN      .02018565 SIGMA
    .074344613703  -.299237524076E-04   -.491276302453E-07   -.306214146130E-04
-.132444009455E-06     .07341500         2
     553 N        558 JE      .00002111 AMEAN      .00915739 SIGMA
     136 N        136 JE      .00145313 AMEAN      .02055577 SIGMA
    .074615985705  -.300478828571E-04   -.487287328771E-07   -.287255332136E-04
-.154070808624E-06     .07418080         3
     515 N        524 JE      .00005604 AMEAN      .00934870 SIGMA
     190 N        191 JE     -.00045776 AMEAN      .03998293 SIGMA
    .075612658474  -.308948293335E-04   -.411247744334E-07   -.352348123944E-04
-.897293631605E-07     .07494500         4
     502 N        541 JE     -.00005692 AMEAN      .01781205 SIGMA
     154 N        154 JE      .00036173 AMEAN      .03583327 SIGMA
    .076479454601  -.309778902949E-04   -.488608248723E-07   -.391820661612E-04
-.591521615776E-07     .07570900         5
     511 N        554 JE     -.00003103 AMEAN      .01597897 SIGMA
     162 N        162 JE     -.00126697 AMEAN      .03087900 SIGMA
    .077362991056  -.309130357396E-04   -.660007329748E-07   -.390862848781E-04
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-.503331835570E-07       .07647400         5
      530 N       613 JE      .00031629 AMEAN      .01719421 SIGMA
      208 N       210 JE      .00043205 AMEAN      .03864943 SIGMA
     .078685242681  -.308837050478E-04  -.918561324970E-07  -.386665155905E-04
-.526174608366E-07       .07723980         7
      230 N       258 JE      .00027643 AMEAN      .01725935 SIGMA
       90 N        90 JE     -.00237092 AMEAN      .03186101 SIGMA
     .079883779345  -.324815477912E-04  -.548742909066E-07  -.449476121309E-04
-.177757622013E-07       .07800300         8
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STATICN D 00HR FOUR SEASONS

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WINTER
   202 N       203 JE      .00017445 AMEAN      .00799148 SIGMA
    55 N        55 JE     -.00137327 AMEAN      .02585585 SIGMA
  .075201199460  -.290747156754E-04  -.948909371982E-07  -.491624571050E-04
.128203755981E-07     .07494500          1
   566 N       585 JE      .00032453 AMEAN      .01221101 SIGMA
   250 N       250 JE     -.00095379 AMEAN      .03567010 SIGMA
  .076289924511  -.302175594887E-04  -.762590474069E-07  -.499645097517E-04
.135187872263E-07     .07570900          2
   647 N       696 JE      .00005214 AMEAN      .01592157 SIGMA
   209 N       214 JE     -.00079727 AMEAN      .04651559 SIGMA
  .076988092343  -.297318476159E-04  -.998512339638E-07  -.456948677989E-04
-.127959762734E-07    .07647400          3
   651 N       676 JE      .00035674 AMEAN      .01337308 SIGMA
   196 N       199 JE     -.00047310 AMEAN      .03863474 SIGMA
  .077913812130  -.313971154573E-04  -.486401086075E-07  -.487132054156E-04
.405458322190E-08     .07723900          4
   601 N       662 JE      .00062950 AMEAN      .01782020 SIGMA
   272 N       275 JE     -.00011937 AMEAN      .04359514 SIGMA
  .078642416241  -.300762517468E-04  -.113385451167E-06  -.457861220678E-04
-.111375163742E-07    .07800300          5
   615 N       672 JE      .00060939 AMEAN      .01632273 SIGMA
   260 N       263 JE     -.00270465 AMEAN      .04367981 SIGMA
  .079821689538  -.314446922648E-04  -.857169991886E-07  -.486738593932E-04
.624845074843E-08     .07876800          6
   612 N       686 JE      .00027257 AMEAN      .01592885 SIGMA
   222 N       225 JE     -.00244308 AMEAN      .03884276 SIGMA
  .081422814858  -.328373602449E-04  -.559935324546E-07  -.493557037266E-04
.100500780010E-07     .07953390          7
   147 N       160 JE      .00024923 AMEAN      .01663688 SIGMA
    59 N        60 JE     -.00471553 AMEAN      .03700902 SIGMA
  .081991710164  -.335173208507E-04  -.364176559349E-07  -.545142973373E-04
.375759098508E-07     .08030000          8
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SPRING
    697 N        705 JE       .00001826 AMEAN       .00864568 SIGMA
    262 N        263 JE      -.00019727 AMEAN       .04851942 SIGMA
   .075982188328  -.299702669149E-04  -.787753781816E-07  -.445813325599E-04
-.227176979176E-07       .07570900         9
    658 N        662 JE       .00022929 AMEAN       .00779777 SIGMA
    292 N        292 JE       .00183909 AMEAN       .02846675 SIGMA
   .076497780574  -.306487884592E-04  -.472888872135E-07  -.439073634353E-04
-.305971782366E-07       .07647400         10
    678 N        690 JE       .00065131 AMEAN       .01185496 SIGMA
    282 N        282 JE       .00004972 AMEAN       .03492715 SIGMA
   .077739578662  -.312147204712E-04  -.506442565393E-07  -.477462468695E-04
-.187751107567E-08       .07723900         11
    583 N        599 JE       .00073548 AMEAN       .01159167 SIGMA
    279 N        280 JE      -.00112547 AMEAN       .03196412 SIGMA
   .078398083466  -.322587317971E-04  -.225450085039E-07  -.493369879129E-04
 .680950634553E-08       .07800300         12
    201 N        204 JE       .00121485 AMEAN       .00875655 SIGMA
     83 N         83 JE      -.00264956 AMEAN       .02664039 SIGMA
   .079036780259  -.329132182930E-04  -.513487590337E-08  -.520922389709E-04
 .203057602270E-07       .07876800         13

SUMMER
    706 N        707 JE      -.00006319 AMEAN       .00550582 SIGMA
    242 N        242 JE       .00209705 AMEAN       .02516438 SIGMA
   .074969594627  -.305047860707E-04  -.406054457413E-07  -.376283416714E-04
-.759892016452E-07       .07418000         14
    689 N        692 JE       .00017126 AMEAN       .00730451 SIGMA
    276 N        276 JE       .00131022 AMEAN       .02410012 SIGMA
   .075490655603  -.300823446374E-04  -.527421842881E-07  -.379863018943E-04
-.718087206402E-07       .07494500         15
    667 N        673 JE       .00046256 AMEAN       .00843615 SIGMA
    234 N        234 JE       .00078373 AMEAN       .03066944 SIGMA
   .076279868693  -.306946496876E-04  -.443561733820E-07  -.397301785651E-04
-.578053413702E-07       .07570900         16
    701 N        705 JE       .00044688 AMEAN       .00851868 SIGMA
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     270 N        270 JE       .00001311 AMEAN       .02920657 SIGMA
    .077438585881  -.324878357897E-04  -.424573305965E-08  -.407746595068E-04
-.519912791988E-07       .07647400         17

   FALL
     127 N        130 JE       .00006332 AMEAN       .00804976 SIGMA
      51 N         51 JE       .00042924 AMEAN       .01921827 SIGMA
    .074513790840  -.281427146752E-04  -.114849322489E-06  -.456952286212E-04
-.110373459218E-07       .07418000         18
     574 N        587 JE       .00009833 AMEAN       .01020188 SIGMA
     214 N        214 JE       .00116902 AMEAN       .04111387 SIGMA
    .075289849626  -.293700168556E-04  -.832818361345E-07  -.415458514951E-04
-.426769294118E-07       .07494500         19
     692 N        710 JE       .00008485 AMEAN       .00973025 SIGMA
     219 N        219 JE       .00800905 AMEAN       .03748946 SIGMA
    .076267439288  -.303959040614E-04  -.588657804861E-07  -.418084904645E-04
-.409929128611E-07       .07570900         20
     665 N        686 JE       .00047898 AMEAN       .01222738 SIGMA
     282 N        285 JE      -.00100485 AMEAN       .04031502 SIGMA
    .077242774614  -.309923111088E-04  -.506504126904E-07  -.440222591979E-04
-.258858625642E-07       .07647400         21
     685 N        696 JE       .00047447 AMEAN       .01093540 SIGMA
     247 N        251 JE      -.00151753 AMEAN       .03649158 SIGMA
    .078626273706  -.330018932578E-04  -.150243854752E-07  -.470429172136E-04
-.616213330289E-08       .07723900         22
     463 N        490 JE       .00026837 AMEAN       .01474414 SIGMA
     136 N        140 JE      -.00223830 AMEAN       .04534904 SIGMA
    .079786041844  -.327418318176E-04  -.385140908387E-07  -.458347364458E-04
-.133804609540E-07       .07800300         23
     232 N        237 JE       .00014125 AMEAN       .01103572 SIGMA
      94 N         94 JE      -.00346199 AMEAN       .03080120 SIGMA
    .081084339323  -.356381647524E-04   .403034286791E-07  -.510665115701E-04
 .143517881 32E-07       .07876800         24

   STATION D 00HR GMT SEASONS COMBINED
     102 N        102 JE       .00011239 AMEAN       .00724097 SIGMA
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      51 N        51 JE      .00124714 AMEAN      .01695610 SIGMA
    .073979445476  -.302712074454E-04  -.448561089766E-07  -.379174319098E-04
-.683772625809E-07      .07341500        1
     685 N       695 JE      .00000386 AMEAN      .00924868 SIGMA
     239 N       249 JE      .00068748 AMEAN      .04539054 SIGMA
    .074682535858  -.297035064228E-04  -.664535440846E-07  -.396820988418E-04
-.565749764122E-07      .07418000        2
     657 N       665 JE     -.00004133 AMEAN      .00798397 SIGMA
     253 N       255 JE      .00118412 AMEAN      .03500768 SIGMA
    .075575819316  -.303915252036E-04  -.496792772127E-07  -.384794088793E-04
-.681120246631E-07      .07494500        3
     692 N       709 JE      .00015133 AMEAN      .00973602 SIGMA
     244 N       251 JE     -.00030336 AMEAN      .04513063 SIGMA
    .076223204820  -.302030861720E-04  -.612360403518E-07  -.414820141261E-04
-.437664639842E-07      .07570900        4
     702 N       723 JE      .00019145 AMEAN      .01201187 SIGMA
     278 N       286 JE     -.00014462 AMEAN      .03981874 SIGMA
    .077073453784  -.308710441991E-04  -.509744883712E-07  -.436832236911E-04
-.284257466426E-07      .07647400        5
     666 N       680 JE      .00043718 AMEAN      .00987463 SIGMA
     264 N       264 JE     -.00084249 AMEAN      .02955455 SIGMA
    .077833998787  -.316471711787E-04  -.344856485515E-07  -.495702127057E-04
 .884999950345E-08      .07723900        6
     631 N       668 JE      .00047499 AMEAN      .01416375 SIGMA
     263 N       272 JE     -.00229513 AMEAN      .04178764 SIGMA
    .079107665996  -.320999149108E-04  -.473864353122E-07  -.482303704820E-04
 .289688176300E-08      .07800300        7
     629 N       683 JE      .00059020 AMEAN      .01622123 SIGMA
     251 N       255 JE     -.00239037 AMEAN      .04196134 SIGMA
    .079944624730  -.324052045828E-04  -.523191868652E-07  -.491021792742E-04
 .750858512163E-08      .07876800        8
     613 N       687 JE      .00051533 AMEAN      .01594820 SIGMA
     239 N       245 JE     -.00194374 AMEAN      .03958906 SIGMA
    .081089156758  -.328678362293E-04  -.565750788939E-07  -.493951123231E-04
 .107113888380E-07      .07953300        9
     169 N       183 JE      .00027336 AMEAN      .01611873 SIGMA
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     60 N        61 JE      -.00472267 AMEAN       .03755874 SIGMA
    .081880292213  -.336675316663E-04  -.293347044346E-07  -.551969779364E-04
 .408634836773E-07       .08030000        10

STATION D 12HR FOUR SEASONS

WINTER
    245 N       252 JE       .00020543 AMEAN       .01075730 SIGMA
     76 N        76 JE      -.00180414 AMEAN       .02248202 SIGMA
    .075696723767  -.296927579965E-04  -.937895666281E-07  -.486743066601E-04
 .866948688293E-08       .07494500         1
    570 N       594 JE       .00010631 AMEAN       .01182782 SIGMA
    211 N       214 JE      -.00151847 AMEAN       .03822676 SIGMA
    .076045751111  -.286218650855E-04  -.127122912961E-06  -.470241082587E-04
-.784226828954E-09       .07570900         2
    572 N       589 JE      -.00010630 AMEAN       .01281770 SIGMA
    245 N       252 JE      -.00089019 AMEAN       .04387340 SIGMA
    .077259886996  -.304970244682E-04  -.739845416645E-07  -.470384723104E-04
-.382941112750E-08       .07647400         3
    610 N       652 JE       .00045741 AMEAN       .01577219 SIGMA
    274 N       275 JE      -.00027503 AMEAN       .04282107 SIGMA
    .077699973561  -.302034034172E-04  -.901166413743E-07  -.463424988997E-04
-.832498267076E-08       .07723900         4
    599 N       657 JE       .00048676 AMEAN       .01607011 SIGMA
    287 N       288 JE      -.00102863 AMEAN       .03846283 SIGMA
    .078947603181  -.308109303553E-04  -.961857083851E-07  -.483569760312E-04
 .603486348781E-08       .07800300         5
    580 N       666 JE       .00079728 AMEAN       .01780286 SIGMA
    233 N       237 JE      -.00189451 AMEAN       .03921588 SIGMA
    .079682994294  -.314227117251E-04  -.837977888897E-07  -.495772900225E-04
 .132230390180E-07       .07876800         6
    498 N       536 JE       .00058122 AMEAN       .01518017 SIGMA
    188 N       188 JE      -.00322845 AMEAN       .03814613 SIGMA
    .080746972925  -.316811749629E-04  -.859430568349E-07  -.516088154792E-04
 .239024257528E-07       .07953380         7
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     255 N        260 JE      .00051778 AMEAN      .01113911 SIGMA
      98 N         98 JE     -.00397870 AMEAN      .02553958 SIGMA
    .082405784303  -.347371980970E-04  -.466387019841E-08  -.543409476729E-04
 .338993037232E-07      .08030000        8

 SPRING
     403 N        417 JE      .00020368 AMEAN      .01062315 SIGMA
     189 N        192 JE     -.00144851 AMEAN      .04073963 SIGMA
    .075044109371  -.288563198972E-04  -.101593848898E-06  -.448593373763E-04
-.161971917202E-07      .07494500        9
     635 N        639 JE     -.00002202 AMEAN      .00852228 SIGMA
     272 N        272 JE      .00030354 AMEAN      .03410877 SIGMA
    .076100040134  -.298719156259E-04  -.743126936749E-07  -.458586213289E-04
-.128445508091E-07      .07570900        10
     659 N        665 JE      .00052909 AMEAN      .00944259 SIGMA
     315 N        317 JE      .00124044 AMEAN      .03328026 SIGMA
    .076716778518  -.307249494268E-04  -.515915733920E-07  -.437925081029E-04
-.287519954136E-07      .07647400        11
     663 N        675 JE      .00067643 AMEAN      .01022552 SIGMA
     314 N        314 JE     -.00035225 AMEAN      .03555745 SIGMA
    .077482199658  -.311805104180E-04  -.463571132521E-07  -.469088142786E-04
-.608255232731E-08      .07723900        12
     639 N        651 JE      .00101609 AMEAN      .01230473 SIGMA
     270 N        273 JE     -.00008199 AMEAN      .03253444 SIGMA
    .078277689904  -.322321307668E-04  -.247620136957E-07  -.473306105450E-04
-.683328793135E-08      .07800300        13
     251 N        264 JE      .00094984 AMEAN      .01218156 SIGMA
     120 N        120 JE     -.00129767 AMEAN      .02919986 SIGMA
    .079551330863  -.335096886654E-04   .941510732266E-10  -.501753848106E-04
 .115324999873E-07      .07876800        14

 SUMMER
     115 N        115 JE      .00010428 AMEAN      .00503920 SIGMA
      50 N         50 JE      .00165838 AMEAN      .02100200 SIGMA
    .074212112946  -.298854870778E-04  -.608736758428E-07  -.377735791438E-04
-.711009701389E-07      .07341500        15
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      658 N        658 JE       .00021084 AMEAN      .00626715 SIGMA
      280 N        280 JE       .00117701 AMEAN      .02372541 SIGMA
     .074962523778  -.301041376787E-04  -.526680054873E-07  -.392155793939E-04
 -.601031392698E-07      .07418000        16
      622 N        629 JE       .00030950 AMEAN      .00757546 SIGMA
      253 N        253 JE       .00195630 AMEAN      .02831583 SIGMA
     .075626273937  -.304690156589E-04  -.481856923327E-07  -.372848474903E-04
 -.770408844900E-07      .07494500        17
      653 N        653 JE       .00069809 AMEAN      .00743414 SIGMA
      253 N        253 JE       .00076047 AMEAN      .02047481 SIGMA
     .076410184654  -.313068666525E-04  -.248364145673E-07  -.391995701413E-04
 -.638318044199E-07      .07570900        18
      695 N        701 JE       .00076420 AMEAN      .00993039 SIGMA
      281 N        281 JE       .00076539 AMEAN      .03112714 SIGMA
     .077231803078  -.318277364320E-04  -.232135557289E-07  -.405036936893E-04
 -.514483283211E-07      .07647400        19

   FALL
      288 N        289 JE       .00002789 AMEAN      .00629417 SIGMA
      131 N        131 JE      -.00007733 AMEAN      .03029892 SIGMA
     .074702463755  -.295728962160E-04  -.755688302420E-07  -.442471655223E-04
 -.225039431792E-07      .07418000        20
      601 N        611 JE      -.00019601 AMEAN      .00922337 SIGMA
      275 N        275 JE       .00061465 AMEAN      .03463331 SIGMA
     .075623162903  -.302091588067E-04  -.617721728559E-07  -.430336787028E-04
 -.318498604862E-07      .07494500        21
      619 N        625 JE       .00019251 AMEAN      .00849939 SIGMA
      277 N        277 JE       .00062156 AMEAN      .03118798 SIGMA
     .076096133738  -.305355209281E-04  -.497897998839E-07  -.423864381247E-04
 -.358914987815E-07      .07570900        22
      616 N        637 JE       .00042148 AMEAN      .01134444 SIGMA
      244 N        245 JE       .00006509 AMEAN      .03576894 SIGMA
     .077300465867  -.317215272635E-04  -.290137114986E-07  -.450572113957E-04
 -.210260508949E-07      .07647400        23
      581 N        599 JE       .00057282 AMEAN      .01213544 SIGMA
      251 N        252 JE      -.00021597 AMEAN      .03641984 SIGMA
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  .078374222534  -.321386131371E-04  -.341790866952E-07  -.459166580456E-04
-.133859375145E-07      .07723900         24
     504 N        523 JE      .00058396 AMEAN      .01208552 SIGMA
     190 N        190 JE     -.00286648 AMEAN      .03233828 SIGMA
  .079450197125  -.331145560273E-04  -.156423351578E-07  -.482443095251E-04
 .824376717580E-09      .07800300         25
     238 N        246 JE      .00069645 AMEAN      .01513175 SIGMA
      73 N         73 JE      .00107205 AMEAN      .03973437 SIGMA
  .080253098401  -.330941080365E-04  -.332928806894E-07  -.454886158652E-04
-.176261962349E-07      .07876800         26

   STATION D 12HR GMT SEASONS COMBINED
     129 N        129 JE      .00028562 AMEAN      .00649157 SIGMA
      50 N         50 JE      .00160527 AMEAN      .02089677 SIGMA
  .073947459705  -.297475484235E-04  -.613793362679E-07  -.379134215541E-04
-.700848771960E-07      .07341500          1
     645 N        649 JE      .00025545 AMEAN      .00797880 SIGMA
     268 N        269 JE      .00059627 AMEAN      .02974363 SIGMA
  .075037773768  -.301867328750E-04  -.544953975909E-07  -.391665897824E-04
-.599752474604E-07      .07418000          2
     606 N        624 JE      .00004018 AMEAN      .01011612 SIGMA
     288 N        288 JE     -.00010885 AMEAN      .04278541 SIGMA
  .075794907465  -.304581834864E-04  -.579937745210E-07  -.401044632266E-04
-.533733608017E-07      .07494500          3
     603 N        611 JE      .00033465 AMEAN      .01114166 SIGMA
     252 N        260 JE      .00010543 AMEAN      .04261765 SIGMA
  .076431893417  -.308604202217E-04  -.452009365738E-07  -.425419486363E-04
-.358610591716E-07      .07570900          4
     627 N        643 JE      .00065522 AMEAN      .00999630 SIGMA
     275 N        275 JE      .00078709 AMEAN      .03442630 SIGMA
  .076833579646  -.311245839960E-04  -.407364048835E-07  -.438660866528E-04
-.277739740326E-07      .07647400          5
     629 N        640 JE      .00043754 AMEAN      .01204562 SIGMA
     299 N        301 JE     -.00005196 AMEAN      .04127314 SIGMA
  .077647641755  -.310449587155E-04  -.525758297977E-07  -.463573941307E-04
-.115294993614E-07      .07723900          6
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     611 N        659 JE       .00056601 AMEAN       .01533323 SIGMA
     262 N        265 JE      -.00229007 AMEAN       .04311119 SIGMA
   .078832795282  -.309978824237E-04  -.799879745070E-07  -.478567255843E-04
.882893395758E-09       .07800300         7
     579 N        660 JE       .00079341 AMEAN       .01832358 SIGMA
     237 N        241 JE      -.00182545 AMEAN       .04138472 SIGMA
   .079667559885  -.317473686701E-04  -.691300877586E-07  -.480452745885E-04
.528108716149E-08       .07876800         8
     557 N        606 JE       .00067609 AMEAN       .01593925 SIGMA
     209 N        216 JE      -.00195685 AMEAN       .04470457 SIGMA
   .080841350228  -.321567148268E-04  -.734357462963E-07  -.485759732423E-04
.578107126228E-08       .07953300         9
     316 N        324 JE       .00064744 AMEAN       .01164233 SIGMA
     128 N        128 JE      -.00384582 AMEAN       .02470810 SIGMA
   .082178321242  -.344272633121E-04  -.117160203563E-07  -.545775692865E-04
.373347423114E-07       .08030000        10
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STATION N 00HR FOUR SEASONS

WINTER
     345 N        359 JE        .00046784 AMEAN      .01277273 SIGMA
     100 N        100 JE        .00035050 AMEAN      .03305866 SIGMA
    .074932573411  -.289664839751E-04  -.987062614042E-07  -.401328092619E-04
-.432496428354E-07      .07418000       1
     404 N        424 JE        .00093351 AMEAN      .01358650 SIGMA
     130 N        130 JE        .00033612 AMEAN      .03230926 SIGMA
    .075821804059  -.304773527736E-04  -.549714751728E-07  -.371139856056E-04
-.695240263965E-07      .07494500       2
     529 N        544 JE        .00064400 AMEAN      .01022277 SIGMA
     214 N        214 JE       -.00094971 AMEAN      .02771327 SIGMA
    .076774683103  -.310458698615E-04  -.402242185578E-07  -.411085019938E-04
-.408129281402E-07      .07570900       3
     476 N        488 JE        .00048655 AMEAN      .01159683 SIGMA
     207 N        207 JE       -.00191957 AMEAN      .02923630 SIGMA
    .077507358099  -.310505861373E-04  -.425443860768E-07  -.457557943174E-04
-.119070622443E-07      .07647400       4
     257 N        260 JE        .00018189 AMEAN      .01061343 SIGMA
     115 N        115 JE       -.00035825 AMEAN      .02473042 SIGMA
    .077929503260  -.306917238119E-04  -.359683519077E-07  -.451326136383E-04
-.149642714959E-07      .07723900       5

SPRING
      76 N         76 JE        .00035731 AMEAN      .00561433 SIGMA
      36 N         36 JE        .00142004 AMEAN      .02450052 SIGMA
    .075654815018  -.315169202752E-04  -.172611994834E-07  -.360314804333E-04
-.870703099174E-07      .07418000       6
     391 N        395 JE        .00114896 AMEAN      .00933454 SIGMA
     159 N        159 JE        .00062977 AMEAN      .02508924 SIGMA
    .075707743701  -.308288027213E-04  -.324142943320E-07  -.367173603616E-04
-.811608589937E-07      .07494580       7
     415 N        417 JE        .00107964 AMEAN      .00790353 SIGMA
     190 N        191 JE        .00168097 AMEAN      .02531245 SIGMA
    .076558955003  -.320358221826E-04  -.571234535200E-08  -.395916039285E-04
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-.587602122498E-07        .07570900         8
     473 N        477 JE       .00062862 AMEAN       .00965470 SIGMA
     216 N        216 JE       .00071256 AMEAN       .02587751 SIGMA
    .077975240890  -.332043337042E-04   .141194064881E-07   -.414836835365E-04
-.479817391152E-07        .07647400         9

  SUMMER
      86 N         86 JE       .00050511 AMEAN       .00697220 SIGMA
      38 N         38 JE      -.00013753 AMEAN       .01937327 SIGMA
    .075535259549  -.309685695473E-04  -.306198727746E-07   -.366148693386E-04
-.777111141469E-07        .07341500        10
     499 N        500 JE       .00065237 AMEAN       .00881852 SIGMA
     210 N        210 JE      -.00036426 AMEAN       .01657734 SIGMA
    .075730102801  -.316902028185E-04  -.661927279529E-08   -.373989493867E-04
-.732340776367E-07        .07418000        11
     509 N        512 JE       .00067512 AMEAN       .00786210 SIGMA
     225 N        225 JE       .00033057 AMEAN       .01636805 SIGMA
    .076026825917  -.321332465206E-04   .221925538649E-08   -.372119981242E-04
-.742153004865E-07        .07494500        12
      79 N         80 JE       .00076989 AMEAN       .00995070 SIGMA
      47 N         47 JE       .00050203 AMEAN       .01360942 SIGMA
    .076855794453  -.327921631762E-04   .127480820621E-07   -.362235526017E-04
-.833916604657E-07        .07570900        13

  FALL
     509 N        517 JE       .00090886 AMEAN       .01095847 SIGMA
     205 N        205 JE      -.00020505 AMEAN       .02194951 SIGMA
    .075320852767  -.301301961779E-04  -.534707210572E-07   -.378152118514E-04
-.674444076983E-07        .07418000        14
     509 N        514 JE       .00053165 AMEAN       .00785829 SIGMA
     244 N        244 JE       .00007612 AMEAN       .01868371 SIGMA
    .076184221139  -.316049427799E-04  -.134210731908E-07   -.384000143082E-04
-.656956906729E-07        .07494500        15
     514 N        517 JE       .00054794 AMEAN       .00849138 SIGMA
     207 N        [illegible] JE       .00034522 AMEAN       .01802577 SIGMA
    .077141206500  -.324277190137E-04   .211285060479E-08   -.382398568320E-04
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-.702552948529E-07       .07570900        16
     298 N        301 JE       .00053115 AMEAN      .01068601 SIGMA
     114 N        118 JE      -.00302350 AMEAN      .03117406 SIGMA
    .077979441775  -.329076317293E-04    .803854016458E-08  -.419353872145E-04
-.410690823436E-07       .07647400        17

   STATION N 00HR GMT SEASONS COMBINED
     193 N        196 JE       .00059901 AMEAN      .00778411 SIGMA
      81 N         81 JE       .00140063 AMEAN      .02737508 SIGMA
    .074772745343  -.292840188176E-04   -.769555847219E-07  -.357981841708E-04
-.843081358996E-07       .07341500         1
     505 N        508 JE       .00077450 AMEAN      .01012429 SIGMA
     225 N        225 JE       .00088690 AMEAN      .02065777 SIGMA
    .075441973594  -.309651835058E-04   -.269140521320E-07  -.371015521651E-04
-.755886937952E-07       .07418000         2
     457 N        463 JE       .00072367 AMEAN      .01157901 SIGMA
     203 N        203 JE      -.00008806 AMEAN      .02272181 SIGMA
    .076083585197  -.316479053785E-04   -.148231771513E-07  -.369145902227E-04
-.758774223599E-07       .07494500         3
     471 N        478 JE       .00056307 AMEAN      .00863241 SIGMA
     201 N        201 JE       .00060300 AMEAN      .02609989 SIGMA
    .077107991364  -.322352124808E-04   -.573989527846E-08  -.384291371919E-04
-.680784658505E-07       .07570900         4
     494 N        501 JE       .00068673 AMEAN      .01046365 SIGMA
     220 N        220 JE      -.00065669 AMEAN      .03160519 SIGMA
    .077608343235  -.319793465455E-04   -.164267239312E-07  -.429934349899E-04
-.335113692327E-07       .07647400         5
     450 N        455 JE       .00026036 AMEAN      .01066228 SIGMA
     189 N        190 JE      -.00045643 AMEAN      .02525807 SIGMA
    .078143248904  -.311601577852E-04   -.425103792811E-07  -.467613205198E-04
-.405214530445E-08       .07723900         6
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STATION N 12HR FOUR SEASONS

WINTER

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      253 N        266 JE       .00012515 AMEAN       .01324448 SIGMA
       52 N         52 JE      -.00050380 AMEAN       .02652525 SIGMA
     .074842185239  -.278788340118E-04  -.127590352902E-06  -.374373158199E-04
-.667674470411E-07       .07418000        1
      434 N        441 JE       .00124579 AMEAN       .01613937 SIGMA
      142 N        142 JE      -.00208673 AMEAN       .03966920 SIGMA
     .075929740824  -.303605365228E-04  -.520655392390E-07  -.412316993071E-04
-.405054530282E-07       .07494500        2
      545 N        556 JE       .00038929 AMEAN       .01130152 SIGMA
      186 N        186 JE      -.00034443 AMEAN       .02644061 SIGMA
     .076768432217  -.312141380307E-04  -.357895097081E-07  -.411699824997E-04
-.426223401289E-07       .07570900        3
      562 N        573 JE       .00039599 AMEAN       .01018334 SIGMA
      195 N        195 JE      -.00111202 AMEAN       .02230670 SIGMA
     .077734520967  -.321811291935E-04  -.104199289985E-07  -.432945122233E-04
-.301424653271E-07       .07647400        4
      538 N        553 JE       .00019871 AMEAN       .01149774 SIGMA
      209 N        209 JE      -.00150558 AMEAN       .02524695 SIGMA
     .078569654683  -.316913278125E-04  -.329570634335E-07  -.480361450707E-04
 .363203426825E-08       .07723900        5

   SPRING
      435 N        438 JE       .00053366 AMEAN       .00916552 SIGMA
      171 N        171 JE       .00134851 AMEAN       .02353535 SIGMA
     .075847480322  -.312871613980E-04  -.193255695740E-07  -.368794120487E-04
-.810753583848E-07       .07494500        6
      467 N        476 JE       .00075289 AMEAN       .01078124 SIGMA
      168 N        168 JE       .00090877 AMEAN       .02761551 SIGMA
     .076122678564  -.313609283261E-04  -.178844941887E-07  -.372978468853E-04
-.813955281313E-07       .07570900        7
      541 N        545 JE       .00035642 AMEAN       .00822514 SIGMA
      221 N        221 JE       .00055497 AMEAN       .02292963 SIGMA
     .077569058569  -.321808139725E-04  -.102805036195E-07  -.419140461907E-04
-.420062806457E-07       .07647400        8
       45 N         45 JE       .00002663 AMEAN       .00757987 SIGMA
       21 N         21 JE      -.00016645 AMEAN       .01187628 SIGMA
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     .079058291264  -.337326096886E-04   .203471861346E-07  -.456574546014E-04
-.154134699482E-07       .07723900          9

  SUMMER
       531 N        532 JE       .00034984 AMEAN      .00680680 SIGMA
       199 N        199 JE       .00822131 AMEAN      .01758167 SIGMA
     .075195491347  -.308811208996E-04  -.245752448538E-07  -.357351490862E-04
-.078278900551E-07       .07418000          10
       595 N        597 JE       .00042195 AMEAN      .00828590 SIGMA
       237 N        237 JE      -.00056185 AMEAN      .02051213 SIGMA
     .076142060438  -.318526175551E-04  -.778746183145E-08  -.373945922702E-04
-.721054863622E-07       .07494500          11
       263 N        264 JE       .00038331 AMEAN      .00907915 SIGMA
       114 N        114 JE       .00061468 AMEAN      .01597999 SIGMA
     .076938962304  -.329374171815E-04   .169217378851E-07  -.373712659850E-04
-.766033659373E-07       .07570900          12

  FALL
       521 N        527 JE       .00028236 AMEAN      .00789974 SIGMA
       187 N        187 JE      -.00028816 AMEAN      .02351643 SIGMA
     .075515245795  -.308091972139E-04  -.339832307851E-07  -.372551586503E-04
-.751815191809E-07       .07418000          13
       580 N        587 JE       .00029775 AMEAN      .00934841 SIGMA
       242 N        242 JE      -.00035018 AMEAN      .02670535 SIGMA
     .075918521053  -.308154681982E-04  -.344195581842E-07  -.381333862908E-04
-.674910099363E-07       .07494500          14
       591 N        595 JE       .00026909 AMEAN      .00843854 SIGMA
       239 N        239 JE      -.00012962 AMEAN      .02980190 SIGMA
     .077219041680  -.321229246281E-04  -.775475155999E-08  -.485580803617E-04
-.546451515696E-07       .07570900          15
       483 N        493 JE       .00053540 AMEAN      .01018878 SIGMA
       234 N        234 JE      -.00102617 AMEAN      .02268718 SIGMA
     .077841608354  -.324190161673E-04  -.256857871999E-08  -.420993310119E-04
-.413863499833E-07       .07647400          16

  STATION N 12HR GMT SEASONS COMBINED
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      538 N        542 JE       .00024575 AMEAN       .00751044 SIGMA
      200 N        200 JE       .00028534 AMEAN       .02154154 SIGMA
    .075289761035  -.307229523672E-04  -.323276086511E-07  -.364432945210E-04
-.816138323838E-07       .07418000          1
      558 N        560 JE       .00019904 AMEAN       .00798989 SIGMA
      198 N        200 JE      -.00078250 AMEAN       .02758753 SIGMA
    .076029127723  -.314262046169E-04  -.157347485333E-07  -.384523685190E-04
-.663887198135E-07       .07494500          2
      482 N        486 JE       .00026024 AMEAN       .01039125 SIGMA
      153 N        153 JE       .00018146 AMEAN       .02647167 SIGMA
    .076604744956  -.315083080805E-04  -.203766372661E-07  -.385194270053E-04
-.696603225845E-07       .07570900          3
      569 N        575 JE       .00034650 AMEAN       .00989130 SIGMA
      213 N        213 JE       .00000030 AMEAN       .02258485 SIGMA
    .077768282808  -.325445363147E-04  -.877500014765E-09  -.432113049094E-04
-.328195805065E-07       .07647400          4
      362 N        367 JE       .00028249 AMEAN       .01064500 SIGMA
      149 N        149 JE      -.00019117 AMEAN       .02184073 SIGMA
    .078691408977  -.325574661978E-04  -.855772750355E-08  -.462939688556E-04
-.115366800166E-07       .07723900          5
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STATION C 00HR FOUR SEASONS

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WINTER
    116 N       141 JE      .00126952 AMEAN      .02177890 SIGMA
     57 N        62 JE      .00211216 AMEAN      .06277720 SIGMA
   .075360925297  -.275572222504E-04  -.200713475929E-06  -.413516053863E-04
-.372740240722E-07      .07494500          1
    171 N       190 JE      .00051293 AMEAN      .01529810 SIGMA
     59 N        59 JE     -.00331024 AMEAN      .01910416 SIGMA
   .074775334714  -.258155391981E-04  -.240502058860E-06  -.489006589924E-04
 .138082095314E-07      .07570900          2
    581 N       616 JE     -.00012704 AMEAN      .01454856 SIGMA
    192 N       196 JE     -.00400198 AMEAN      .04031813 SIGMA
   .075971117835  -.287312048184E-04  -.135673319214E-06  -.504574631009E-04
 .168030006980E-07      .07647400          3
    546 N       595 JE      .00027232 AMEAN      .01748873 SIGMA
    218 N       220 JE     -.00162203 AMEAN      .04316938 SIGMA
   .077106645223  -.295541198246E-04  -.123883678984E-06  -.504891189695E-04
 .157795253951E-07      .07723900          4
    536 N       604 JE     -.00010520 AMEAN      .01915953 SIGMA
    172 N       179 JE     -.00318761 AMEAN      .05272502 SIGMA
   .077914884648  -.290628183349E-04  -.149349665417E-06  -.498378099807E-04
 .140946495449E-07      .07800300          5
    473 N       545 JE      .00053707 AMEAN      .01938740 SIGMA
    177 N       178 JE     -.00206350 AMEAN      .03916397 SIGMA
   .078874009513  -.297979857503E-04  -.138820377576E-06  -.478067214484E-04
 .214294550984E-08      .07876800          6
    536 N       597 JE      .00016121 AMEAN      .01745227 SIGMA
    202 N       208 JE     -.00058131 AMEAN      .04297706 SIGMA
   .080176842168  -.312679640321E-04  -.103212535187E-06  -.491983789699E-04
 .661117577379E-08      .07953300          7
    544 N       580 JE      .00057462 AMEAN      .01424153 SIGMA
    183 N       185 JE     -.00210043 AMEAN      .04214261 SIGMA
   .081540630907  -.330672711686E-04  -.513902999155E-07  -.512787023508E-04
 .153135809295E-07      .08030000          8
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  SPRING
     112 N       119 JE      .00015274 AMEAN      .01263836 SIGMA
      40 N        40 JE     -.00262858 AMEAN      .01634909 SIGMA
    .075049432207  -.264739645731E-04  -.217119525372E-06  -.461637525465E-04
 .615762891068E-08       .07570908          9
     397 N       431 JE      .00013706 AMEAN      .01602730 SIGMA
     133 N       133 JE     -.00147809 AMEAN      .03584016 SIGMA
    .076532932459  -.297199788035E-04  -.111711889434E-06  -.493093917482E-04
 .151704953332E-07       .07647480         10
     528 N       557 JE     -.00044136 AMEAN      .01383060 SIGMA
     198 N       198 JE     -.00188500 AMEAN      .03423068 SIGMA
    .076932028242  -.299919591061E-04  -.100326256716E-06  -.487317160567E-04
 .115813422709E-07       .07723900         11
     611 N       643 JE     -.00000036 AMEAN      .01453319 SIGMA
     238 N       238 JE     -.00040533 AMEAN      .03649474 SIGMA
    .077550899087  -.314228748153E-04  -.554447515007E-07  -.483063381137E-04
 .336005104320E-08       .07800300         12
     573 N       597 JE      .00041183 AMEAN      .01498374 SIGMA
     198 N       201 JE     -.00079198 AMEAN      .02786059 SIGMA
    .078348449460  -.313220122889E-04  -.598990495202E-07  -.502270348586E-04
 .151819968970E-07       .07876800         13
     467 N       539 JE      .00091901 AMEAN      .01749101 SIGMA
     168 N       168 JE     -.00100238 AMEAN      .02964265 SIGMA
    .080199647439  -.322069546225E-04  -.715872135145E-07  -.489754574673E-04
 .856678871500E-08       .07953300         14
     348 N       375 JE      .00060149 AMEAN      .01559159 SIGMA
     113 N       115 JE     -.00208809 AMEAN      .03854776 SIGMA
    .080508429643  -.328822596816E-04  -.408991403385E-07  -.522967915027E-04
 .204746085702E-07       .08030000         15

  SUMMER
     469 N       491 JE      .00021151 AMEAN      .01227337 SIGMA
     160 N       160 JE     -.00131275 AMEAN      .02710242 SIGMA
    .075144901493  -.289405409807E-04  -.114335727585E-06  -.456971494182E-04
-.395641637975E-08       .07570900         16
     679 N       698 JE      .00012914 AMEAN      .01040297 SIGMA
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       226 N        226 JE      -.00142879 AMEAN       .02710947 SIGMA
      .076047852727  -.301548811847E-04   -.754052536408E-07   -.472749372994E-04
    .222060792569E-08       .07647400        17
       592 N        621 JE       .00000582 AMEAN       .01477847 SIGMA
       170 N        171 JE       .00038270 AMEAN       .03842247 SIGMA
      .077100334883  -.312494979834E-04   -.574327406769E-07   -.451418862102E-04
   -.167388992987E-07       .07723900        18
       647 N        665 JE       .00062791 AMEAN       .01318128 SIGMA
       214 N        214 JE      -.00040739 AMEAN       .03364658 SIGMA
      .077384929601  -.314225907145E-04   -.472152672564E-07   -.430918978062E-04
   -.302638630547E-07       .07800300        19
       412 N        437 JE       .00077457 AMEAN       .01227418 SIGMA
       163 N        163 JE      -.00055841 AMEAN       .03165494 SIGMA
      .077785490101  -.321807373466E-04   -.268095111126E-07   -.437323282191E-04
   -.286243545441E-07       .07876800        20

     FALL
       159 N        167 JE       .00025371 AMEAN       .01244965 SIGMA
        52 N         52 JE      -.00246044 AMEAN       .01574213 SIGMA
      .074051425143  -.264080134963E-04   -.195214059218E-06   -.475888686654E-04
    .110569676827E-07       .07494500        21
       126 N        141 JE       .00037929 AMEAN       .01574286 SIGMA
        52 N         52 JE      -.00088878 AMEAN       .02932760 SIGMA
      .075236226109  -.276078246712E-04   -.170896331347E-06   -.476351778662E-04
    .570707349095E-08       .07570900        22
       622 N        665 JE       .00008284 AMEAN       .01518229 SIGMA
       216 N        217 JE       .00004649 AMEAN       .03958908 SIGMA
      .076114733102  -.288795964964E-04   -.130772678029E-06   -.431955709789E-04
   -.251010716276E-07       .07647400        23
       621 N        659 JE       .00012373 AMEAN       .01386572 SIGMA
       221 N        221 JE      -.00193252 AMEAN       .03029742 SIGMA
      .077152817523  -.304548724495E-04   -.846158711023E-07   -.492155122474E-04
    .964118941603E-08       .07723900        24
       601 N        661 JE       .00025035 AMEAN       .01725350 SIGMA
       230 N        234 JE       .00061092 AMEAN       .04435176 SIGMA
      .078161830693  -.305443726102E-04   -.982396884887E-07   -.438857829728E-04
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-.236392904457E-07       .07800380          25
      629 N        680 JE       .00038010 AMEAN       .01528576 SIGMA
      205 N        205 JE      -.00180265 AMEAN       .04469303 SIGMA
       .079444944914  -.316569706641E-04  -.724893923213E-07  -.489495564258E-04
 .759655530984E-08       .07876800          26
      570 N        598 JE       .00050791 AMEAN       .01426663 SIGMA
      176 N        176 JE      -.00153381 AMEAN       .03852541 SIGMA
       .080349887916  -.334878249907E-04  -.204264573137E-07  -.487949888835E-04
 .227369269087E-08       .07953300          27

   STATION C 00HR GMT SEASONS COMBINED
      241 N        278 JE       .00067565 AMEAN       .01919266 SIGMA
      105 N        106 JE      -.00147431 AMEAN       .05060921 SIGMA
       .074842283265  -.277239381386E-04  -.172601591584E-06  -.469218243608E-04
 .178077968485E-08       .07494500           1
      542 N        682 JE       .00022881 AMEAN       .01577089 SIGMA
      209 N        212 JE      -.00164772 AMEAN       .04477083 SIGMA
       .075196358816  -.279315360067E-04  -.159439236787E-06  -.449826084178E-04
-.829075927716E-08       .07570900           2
      661 N        698 JE       .00009230 AMEAN       .01496071 SIGMA
      232 N        234 JE      -.00035377 AMEAN       .03241584 SIGMA
       .075987225441  -.296563753482E-04  -.970172631318E-07  -.456377518538E-04
-.671588990091E-08       .07647400           3
      584 N        624 JE      -.00000424 AMEAN       .01648565 SIGMA
      181 N        189 JE      -.00166467 AMEAN       .05331415 SIGMA
       .077080062284  -.301489912137E-04  -.947070406343E-07  -.466026949549E-04
-.542557404957E-08       .07723900           4
      641 N        687 JE       .00016445 AMEAN       .01683484 SIGMA
      212 N        215 JE      -.00161841 AMEAN       .04486199 SIGMA
       .078104612716  -.315760618925E-04  -.528216917681E-07  -.466756313567E-04
-.391824812570E-08       .07800300           5
      618 N        679 JE       .00032284 AMEAN       .01522870 SIGMA
      230 N        239 JE      -.00120659 AMEAN       .04240741 SIGMA
       .078587864990  -.316645158143E-04  -.559654636406E-07  -.478246143359E-04
-.163746659431E-08       .07876800           5
      511 N        579 JE       .00047043 AMEAN       .01817861 SIGMA
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      178 N        187 JE      -.00165116 AMEAN       .04670829 SIGMA
     .080096709270  -.327360963074E-04  -.499008186073E-07  -.487423622906E-04
  .453386587395E-08       .07953300        7
      567 N        603 JE       .00062077 AMEAN       .01537770 SIGMA
      199 N        201 JE      -.00270583 AMEAN       .04040811 SIGMA
     .080922328601  -.330978026930E-04  -.385322167309E-07  -.521727808088E-04
  .191537477898E-07       .08030000        8

 STATION C 12HR FOUR SEASONS

 WINTER
       80 N         82 JE       .00134301 AMEAN       .01134504 SIGMA
       30 N         30 JE       .00095520 AMEAN       .00706741 SIGMA
     .073710630266  -.228346300486E-04  -.356642813504E-06  -.436358975351E-04
 -.366736136159E-08       .07494500        1
       86 N         95 JE       .00035411 AMEAN       .01629710 SIGMA
       16 N         16 JE      -.00677772 AMEAN       .02167341 SIGMA
     .075313248159  -.255896664690E-04  -.261199629377E-06  -.544099852939E-04
  .497229030730E-07       .07570900        2
      435 N        491 JE       .00025563 AMEAN       .01800248 SIGMA
      180 N        181 JE       .00067104 AMEAN       .04074680 SIGMA
     .076252243737  -.276656681083E-04  -.193180943720E-06  -.470060522977E-04
 -.344016191205E-09       .07647400        3
      555 N        610 JE      -.00021973 AMEAN       .01606956 SIGMA
      201 N        202 JE      -.00190853 AMEAN       .04170678 SIGMA
     .076997308009  -.296754468676E-04  -.117558815280E-06  -.488684597396E-04
  .107464264562E-07       .07723900        4
      505 N        557 JE       .00003111 AMEAN       .02221290 SIGMA
      198 N        202 JE      -.00062715 AMEAN       .04964564 SIGMA
     .078127126125  -.300672933888E-04  -.116072607540E-06  -.488420822374E-04
  .624477074892E-08       .07800300        5
      524 N        581 JE       .00016652 AMEAN       .01824548 SIGMA
      171 N        181 JE      -.00102817 AMEAN       .04403188 SIGMA
     .078838334584  -.304322137129E-04  -.108817682351E-06  -.490529138647E-04
  .359767448199E-08       .07876800        6
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    509 N       579 JE      .00023797 AMEAN      .01825127 SIGMA
    198 N       201 JE     -.00193491 AMEAN      .04040826 SIGMA
   .080026425865  -.314015657689E-04  -.922258506066E-07  -.508177813169E-04
 .158253550920E-07      .07953300          7
    462 N       507 JE      .00044219 AMEAN      .01585672 SIGMA
    188 N       193 JE     -.00514461 AMEAN      .04184472 SIGMA
   .081564556731  -.345650743688E-04  -.522893523038E-08  -.548969520737E-04
 .348177951990E-07      .08030000          8
    248 N       380 JE      .00054457 AMEAN      .02000838 SIGMA
    102 N       103 JE      .00002256 AMEAN      .04183130 SIGMA
   .082406667024  -.332052043176E-04  -.646419583941E-07  -.495401021245E-04
 .990922803992E-08      .08106200          9

  SPRING
    301 N       318 JE      .00021295 AMEAN      .01312645 SIGMA
    100 N       101 JE     -.00399661 AMEAN      .02888628 SIGMA
   .076139446930  -.290719417376E-04  -.135193930588E-06  -.488510085360E-04
 .177910747801E-07      .07647400          10
    466 N       512 JE     -.80007597 AMEAN      .01625396 SIGMA
    215 N       215 JE      .00030544 AMEAN      .03645622 SIGMA
   .076796243733  -.303097511508E-04  -.907820504837E-07  -.476745753409E-04
 .303262689858E-08      .07723900          11
    432 N       465 JE      .00070738 AMEAN      .01670197 SIGMA
    172 N       173 JE     -.00307566 AMEAN      .03916070 SIGMA
   .077609601382  -.303358690007E-04  -.921737088672E-07  -.500348686987E-04
 .169009328774E-07      .07800300          12
    587 N       614 JE      .00045419 AMEAN      .01463366 SIGMA
    201 N       202 JE     -.00182689 AMEAN      .03157577 SIGMA
   .078803975761  -.317247663821E-04  -.585981686839E-07  -.507525583432E-04
 .180347218276E-07      .07876800          13
    539 N       569 JE      .00051507 AMEAN      .01421517 SIGMA
    223 N       223 JE     -.00287111 AMEAN      .03516092 SIGMA
   .080244267087  -.330443121277E-04  -.370242567290E-07  -.515777649597E-04
 .210546766941E-07      .07953300          14
    375 N       423 JE      .00079344 AMEAN      .01703104 SIGMA
    178 N       178 JE      .00061106 AMEAN      .02692884 SIGMA
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    .080623726684  -.326331959913E-04  -.538423372070E-07  -.493483936595E-04
  .939045747715E-08      .38030000        15

  SUMMER
     355 N       373 JE     -.00004078 AMEAN      .01342809 SIGMA
     133 N       133 JE     -.00132252 AMEAN      .03320106 SIGMA
    .075130339656  -.290133303429E-04  -.112139295423E-06  -.452178922265E-04
 -.769563380559E-08      .07570900        16
     595 N       609 JE     -.00005210 AMEAN      .01126172 SIGMA
     246 N       247 JE     -.00037549 AMEAN      .03526878 SIGMA
    .076092496624  -.304555925747E-04  -.706356968813E-07  -.452472080418E-04
 -.105488633346E-07      .07647400        17
     526 N       556 JE     -.00012696 AMEAN      .01330268 SIGMA
     208 N       208 JE      .00074210 AMEAN      .03680023 SIGMA
    .076796692980  -.314243847545E-04  -.438332611923E-07  -.427053419662E-04
 -.335411697701E-07      .07723900        18
     593 N       615 JE      .00018075 AMEAN      .01192169 SIGMA
     214 N       217 JE     -.00254871 AMEAN      .03748987 SIGMA
    .078824874917  -.321760576239E-04  -.333785297614E-07  -.478653046258E-04
 -.259236554952E-08      .07800400        19
     326 N       352 JE      .00209961 AMEAN      .01280475 SIGMA
     150 N       150 JE     -.00024834 AMEAN      .02887523 SIGMA
    .077839369956  -.323533648650E-04  -.235594993941E-07  -.450320023136E-04
 -.180776775489E-07      .07876800        20

  FALL
      91 N        95 JE      .00023884 AMEAN      .01072141 SIGMA
       8 N         8 JE     -.00577191 AMEAN      .03899301 SIGMA
    .074822179924  -.285948341695E-04  -.134221747253E-06  -.526137260707E-04
  .339944892122E-07      .07494500        21
     240 N       254 JE      .00009585 AMEAN      .01303679 SIGMA
      80 N        81 JE     -.00157849 AMEAN      .03842507 SIGMA
    .075341895531  -.282316684595E-04  -.148372222206E-06  -.478050903915E-04
  .122672991922E-07      .07570900        22
     689 N       667 JE     -.00011848 AMEAN      .01724950 SIGMA
     253 N       253 JE     -.00082682 AMEAN      .03643744 SIGMA
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     .076114410248  -.296093170327E-04  -.103369417468E-06  -.472212404955E-04
-.452156102704E-09        .07647400         23
      641 N        693 JE      -.00016662 AMEAN       .01576146 SIGMA
      234 N        248 JE      -.00102243 AMEAN       .05140103 SIGMA
     .077254028385  -.301630756097E-04  -.996926969734E-07  -.445653464658E-04
-.164632400067E-07        .07723900         24
      585 N        632 JE       .00025951 AMEAN       .01508314 SIGMA
      215 N        220 JE      -.00346073 AMEAN       .04574497 SIGMA
     .078267436987  -.310176646715E-04  -.784668460403E-07  -.488185339044E-04
 .982118832189E-08        .07800300         25
      598 N        625 JE       .00056807 AMEAN       .01390782 SIGMA
      234 N        237 JE      -.00151375 AMEAN       .04656462 SIGMA
     .079354746731  -.326738597128E-04  -.385244129582E-07  -.471460913078E-04
-.637494363270E-08        .07876800         26
      493 N        562 JE       .00053618 AMEAN       .01687016 SIGMA
      193 N        194 JE      -.00271715 AMEAN       .04464628 SIGMA
     .080686454931  -.335045549947E-04  -.299049815553E-07  -.507972961023E-04
 .150010379997E-07        .07953300         27

   STATION C 12HR SEAPONS COMBINED
      163 N        185 JE       .00071632 AMEAN       .01990139 SIGMA
       39 N         43 JE       .00205894 AMEAN       .06377341 SIGMA
     .074132127585  -.261809486929E-04  -.217797523168E-06  -.453675680083E-04
-.450423881798E-08        .07494500          1
      507 N        540 JE      -.00013041 AMEAN       .01514852 SIGMA
      166 N        172 JE      -.00182289 AMEAN       .04653447 SIGMA
     .075358915305  -.284656154898E-04  -.139066016458E-06  -.462685745843E-04
-.645572242094E-09        .07570900          2
      587 N        624 JE       .00020079 AMEAN       .01661918 SIGMA
      225 N        233 JE      -.00203609 AMEAN       .04869516 SIGMA
     .076271591388  -.305183898072E-04  -.754774798930E-07  -.459876125065E-04
-.911324646356E-08        .07647400          3
      540 N        564 JE      -.00005009 AMEAN       .01371726 SIGMA
      193 N        199 JE      -.00019837 AMEAN       .04790721 SIGMA
     .076979459084  -.308788279965E-04  -.673526331249E-07  -.427948518739E-04
-.328083986666E-07        .07723900          4
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     516 N       536 JE     -.00013569 AMEAN      .01543790 SIGMA
     183 N       187 JE     -.00199122 AMEAN      .04531566 SIGMA
    .077486628838  -.308534920123E-04  -.676901069213E-07  -.473520275576E-04
 -.184028983355E-09      .07800300          5
     586 N       620 JE      .00035943 AMEAN      .01491915 SIGMA
     228 N       228 JE     -.00116632 AMEAN      .04044945 SIGMA
    .079859615607  -.320533910711E-04  -.586325706788E-07  -.484418142981E-04
  .421852420233E-08      .07876800          6
     538 N       589 JE      .00043485 AMEAN      .01567976 SIGMA
     225 N       226 JE     -.00274972 AMEAN      .03937568 SIGMA
    .080582865266  -.336062385385E-04  -.296460825201E-07  -.512731628622E-04
  .164357581508E-07      .07953300          7
     560 N       589 JE      .00086630 AMEAN      .01236586 SIGMA
     260 N       260 JE     -.00323612 AMEAN      .03194724 SIGMA
    .081189039600  -.344179522903E-04  -.163738061022E-08  -.540332986874E-04
  .308686457900E-07      .08030000          8
     299 N       342 JE      .00043411 AMEAN      .01869886 SIGMA
     100 N       102 JE     -.00096213 AMEAN      .04136389 SIGMA
    .082547643058  -.339103645200E-04  -.422930034466E-07  -.513051322245E-04
  .189108876961E-07      .08106200          9
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APPENDIX D

DENSITY RATIO PROFILES FROM STATION E

DENSITY RATIO PROFILES FOR STATION E

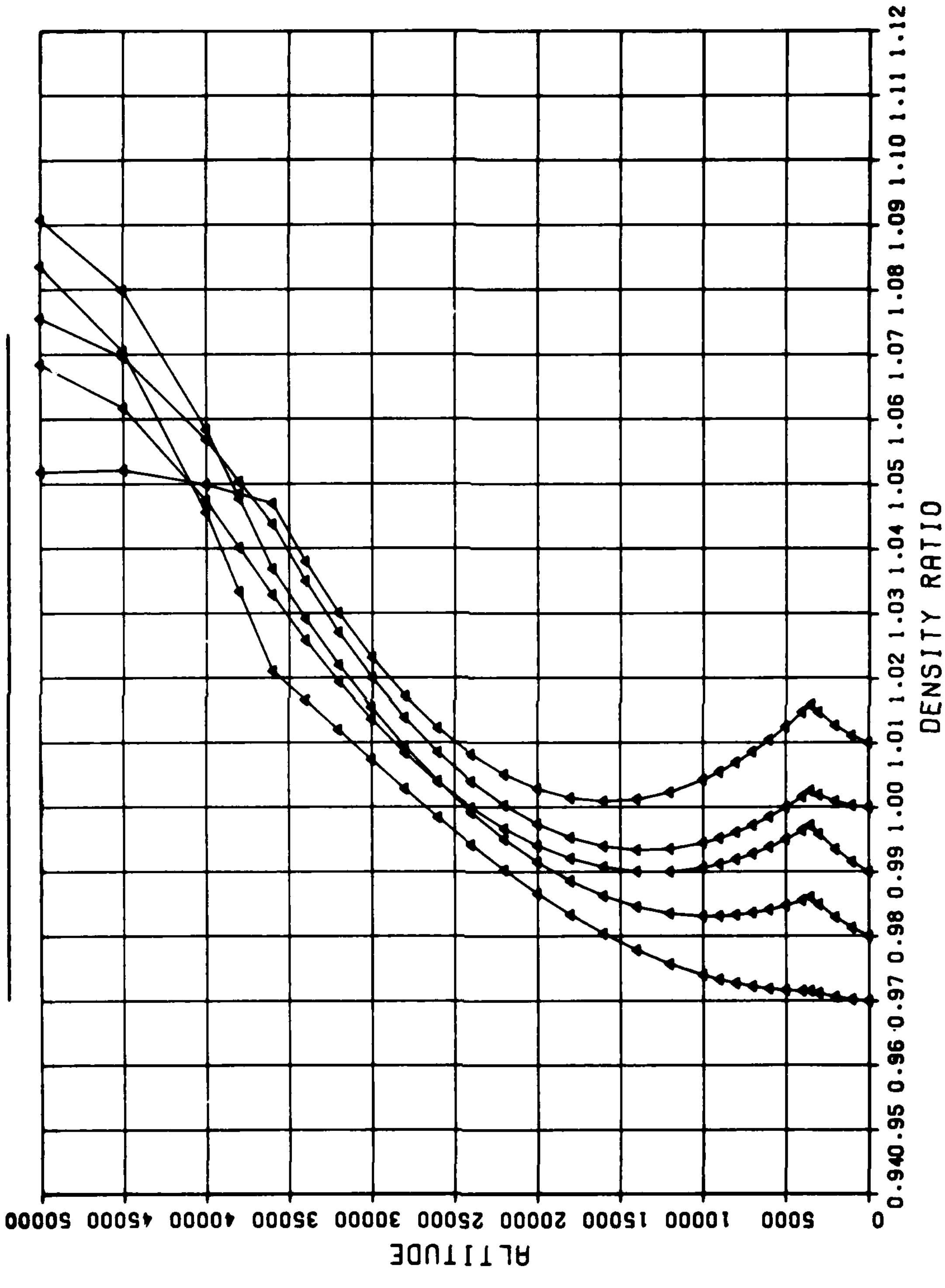
Station E is in the mid-Atlantic east of Bermuda. The uniformity and the shape of the density profiles indicate that the U.S. Standard atmosphere does not represent the atmosphere over station E too well for the period sampled. Almost all the curves above 3,500 ft are fishhook shaped. Below 3,500 ft, the density ratios increase with altitude. The lapse rate is larger than standard, which is referred to in meteorology as a "superadiabat." From 3,500 to 35,000 ft, the density ratio curves are all concave, as seen from the right. That is, density to about 15,000 ft decreases with altitude more than in the standard atmosphere. Above 15,000 ft, the density ratios increase with altitude. Density ratios are all greater than one above 30,000 ft, and they grow larger, regardless of surface density ratios. Overall, when density is two percent below standard at the surface, it averages three percent above standard at 35,000 ft. Above 35,000 ft, the curves are more erratic, which is probably due to the higher noise level in the observations.

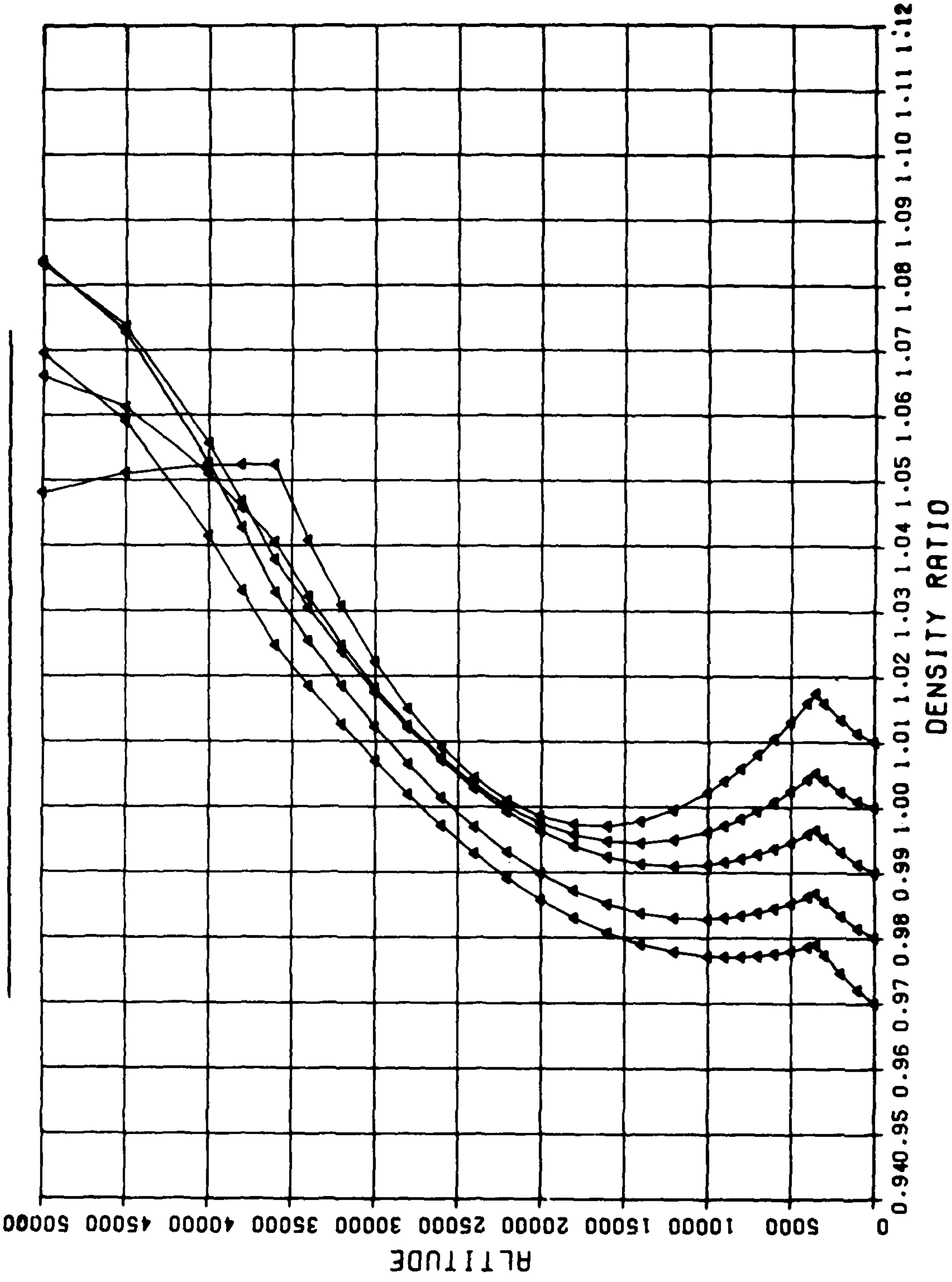
Some seasonal differences are apparent in this region. For example, in summer, both at 2100 hr and 0900 hr local time, the density ratios increase linearly from 35,000 to 45,000 ft to a value of 11 percent above standard. This seasonal behavior may be associated with the seasonal change in the height and temperature of the tropopause.

The diurnal differences are very small. When the 9 a.m. and 9 p.m. curves are superimposed, the coincidence of the curves is remarkable. This could mean that there are no diurnal changes in density; or that, as the surface temperature and density change diurnally, the density aloft changes in a corresponding manner, and the correlation is preserved. It could also be due to the fact that 9 a.m. and 9 p.m. temperatures are nearly the same. At stations N and V, the sonde times would likely correspond to greater differences in surface temperature and density.

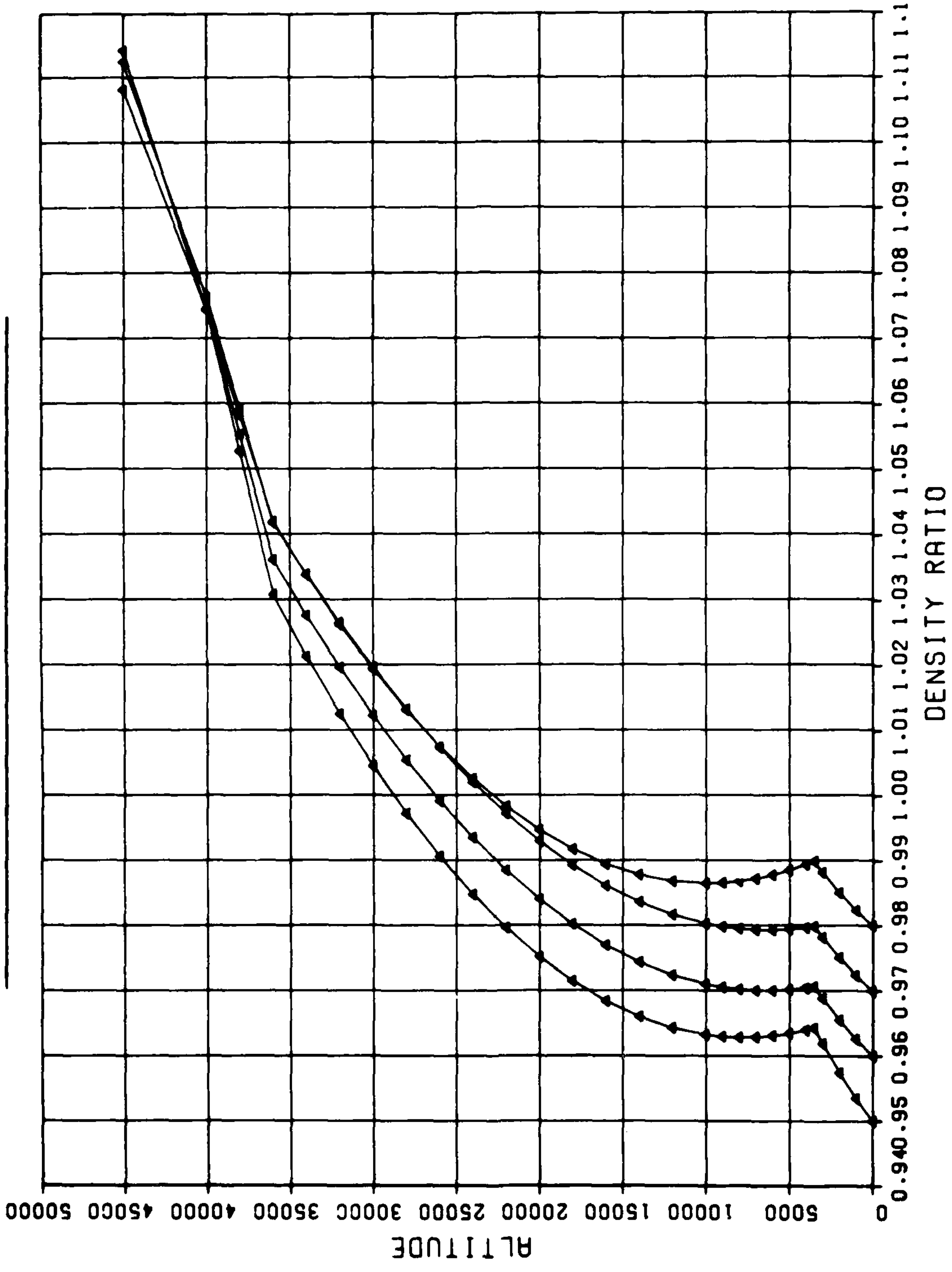
The values for surface density reflect the seasonal changes in temperature. Surface density class medians ranged from 0.95 to 0.98 in summer; in winter, they ranged from 0.97 to 1.02.

Station E
Spring 0000 hr G.m.t.
(20 hr 48 min local time)

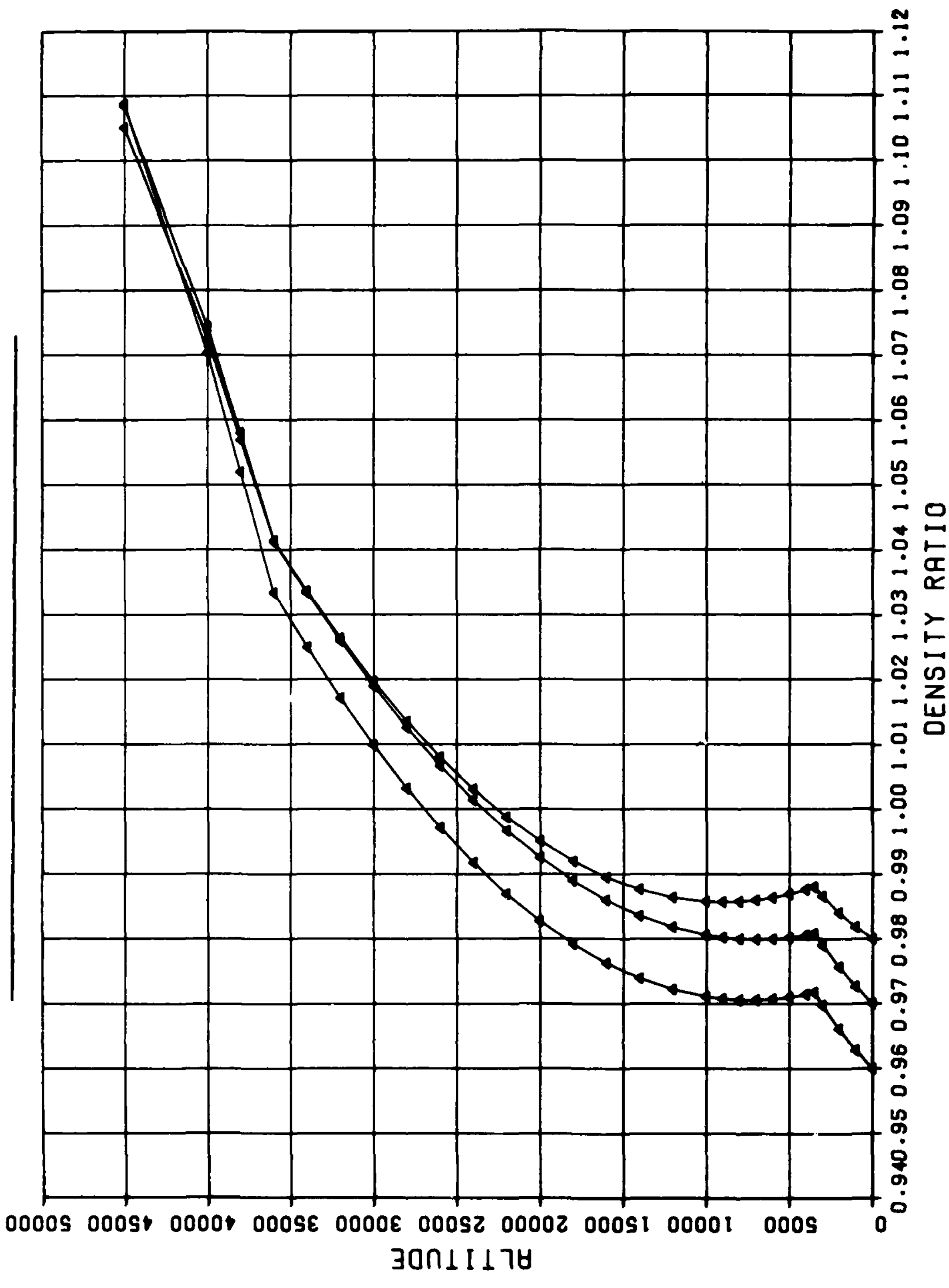




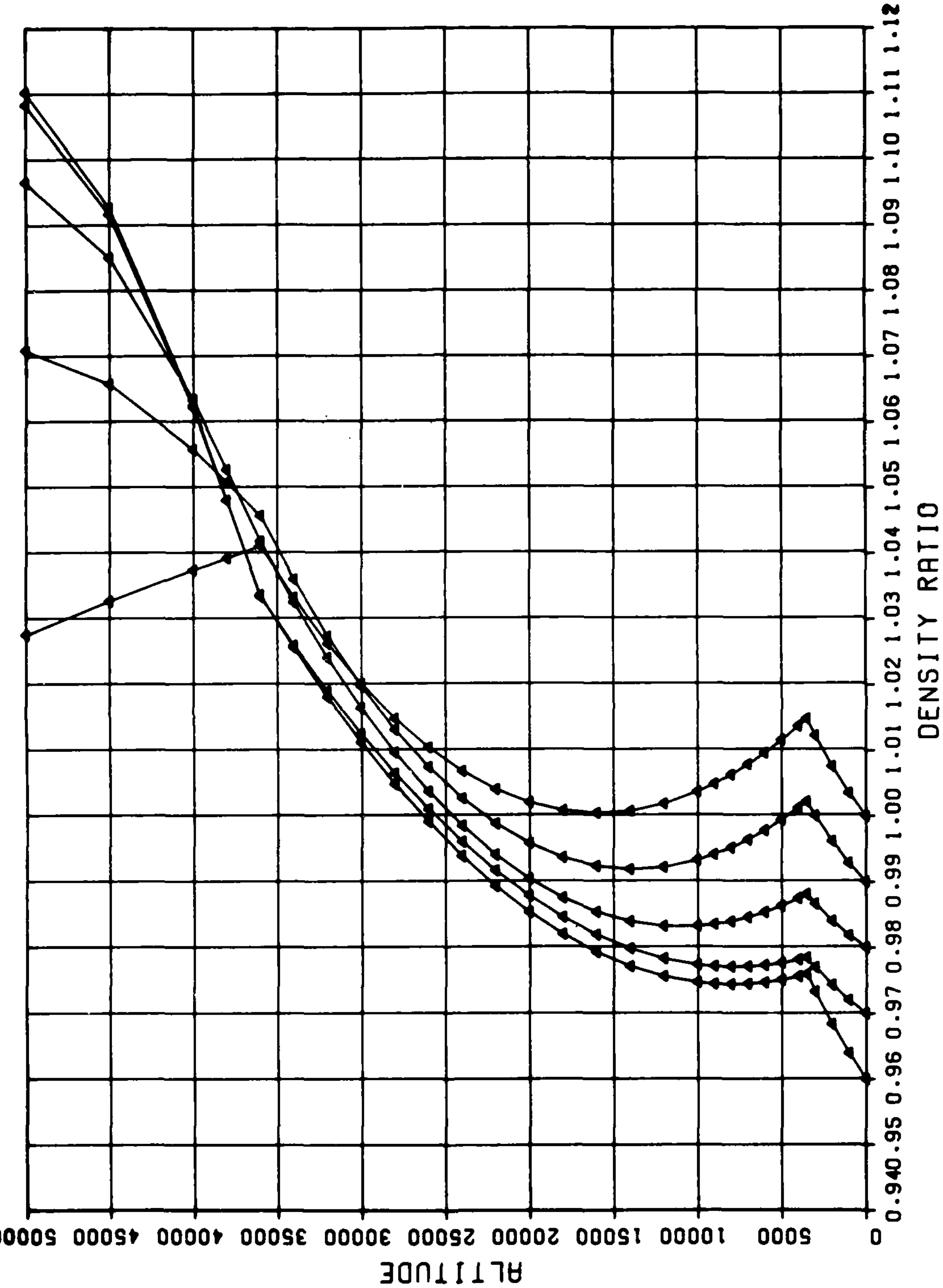
Station E
Spring 1200 hr G.m.t.
(8 hr 48 min local time)



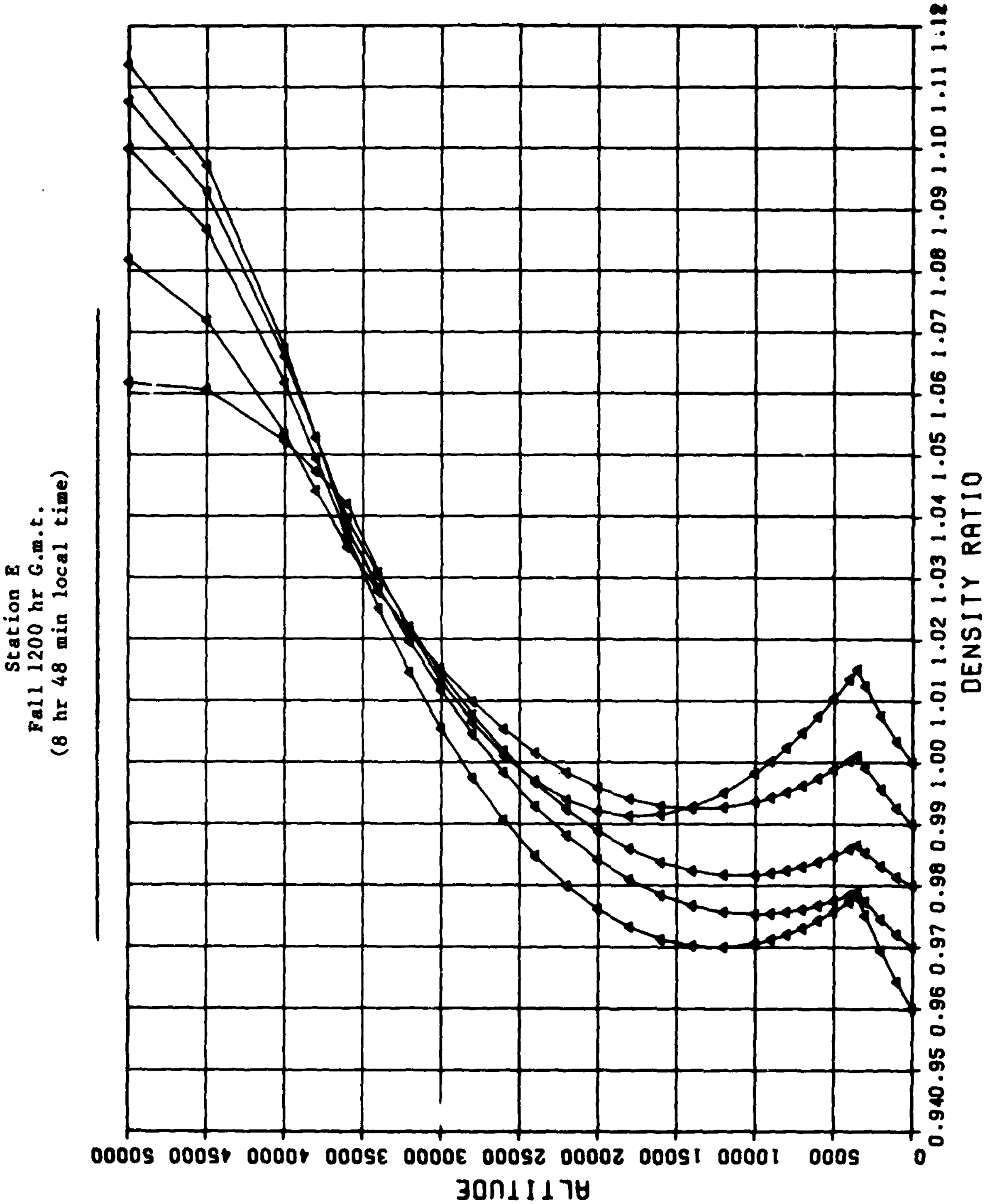
Station E
Summer 0000 hr G.m.t.
(20 hr 48 min local time)

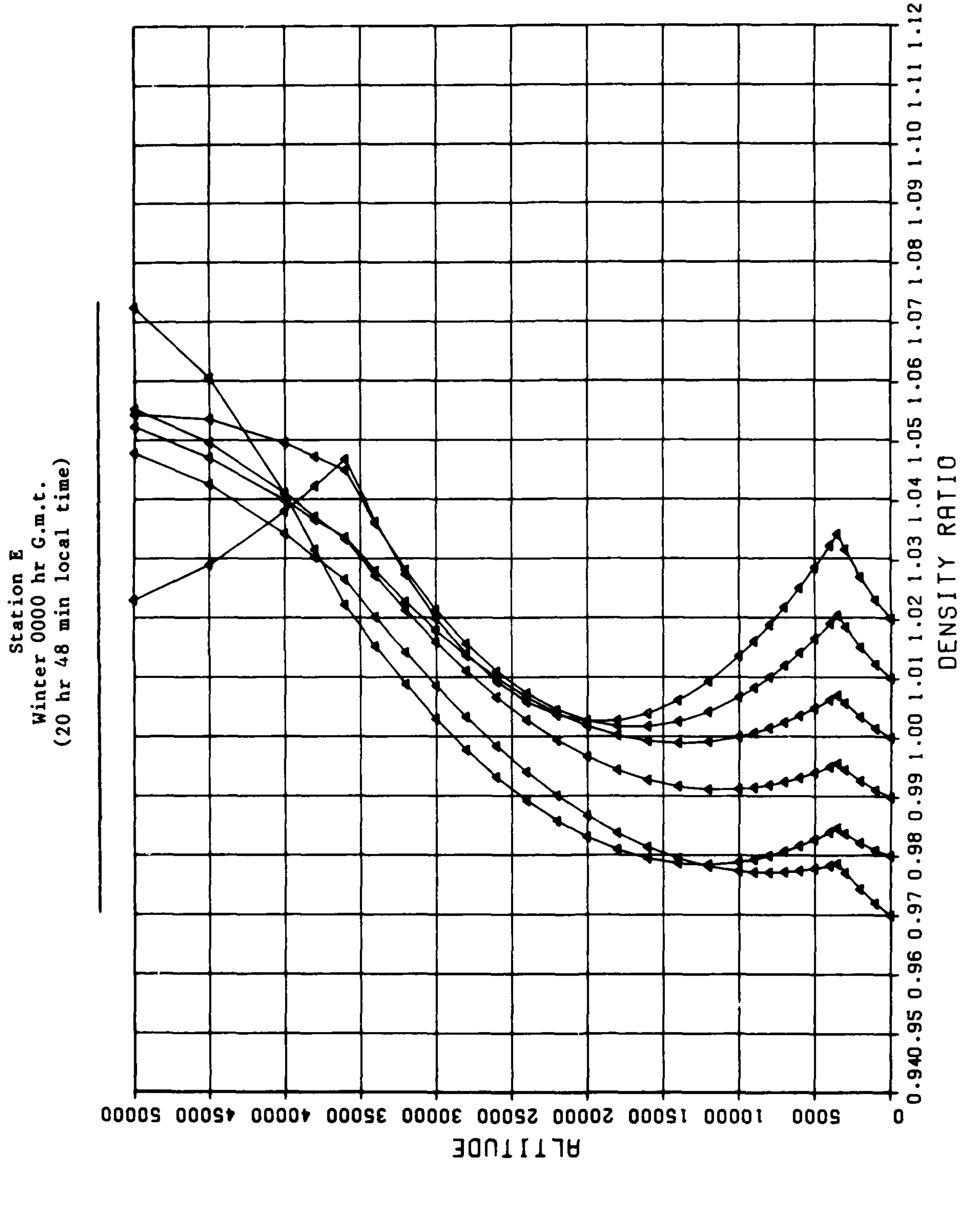


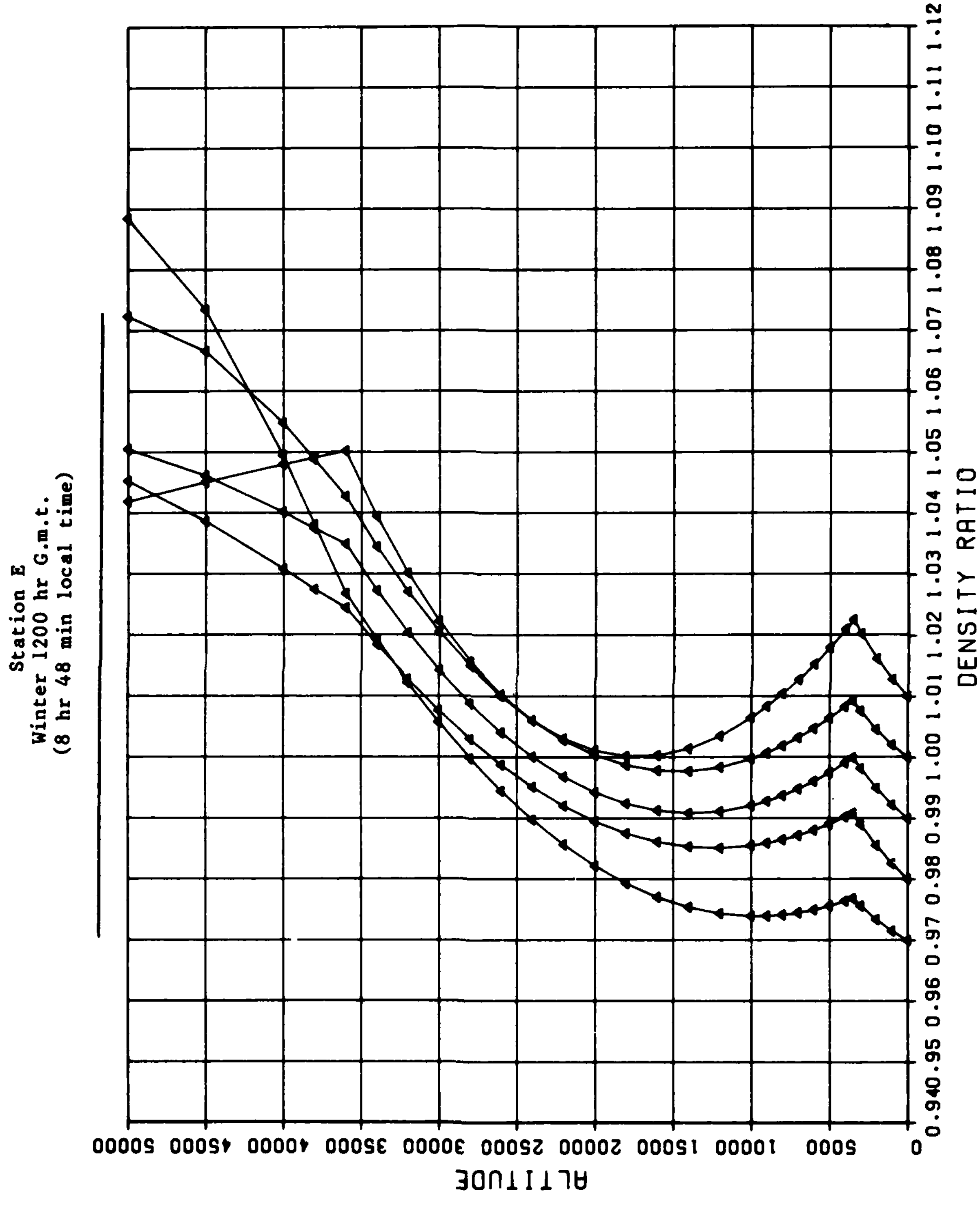
Station E
Summer 1200 hr G.m.t.
(8 hr 48 min local time)

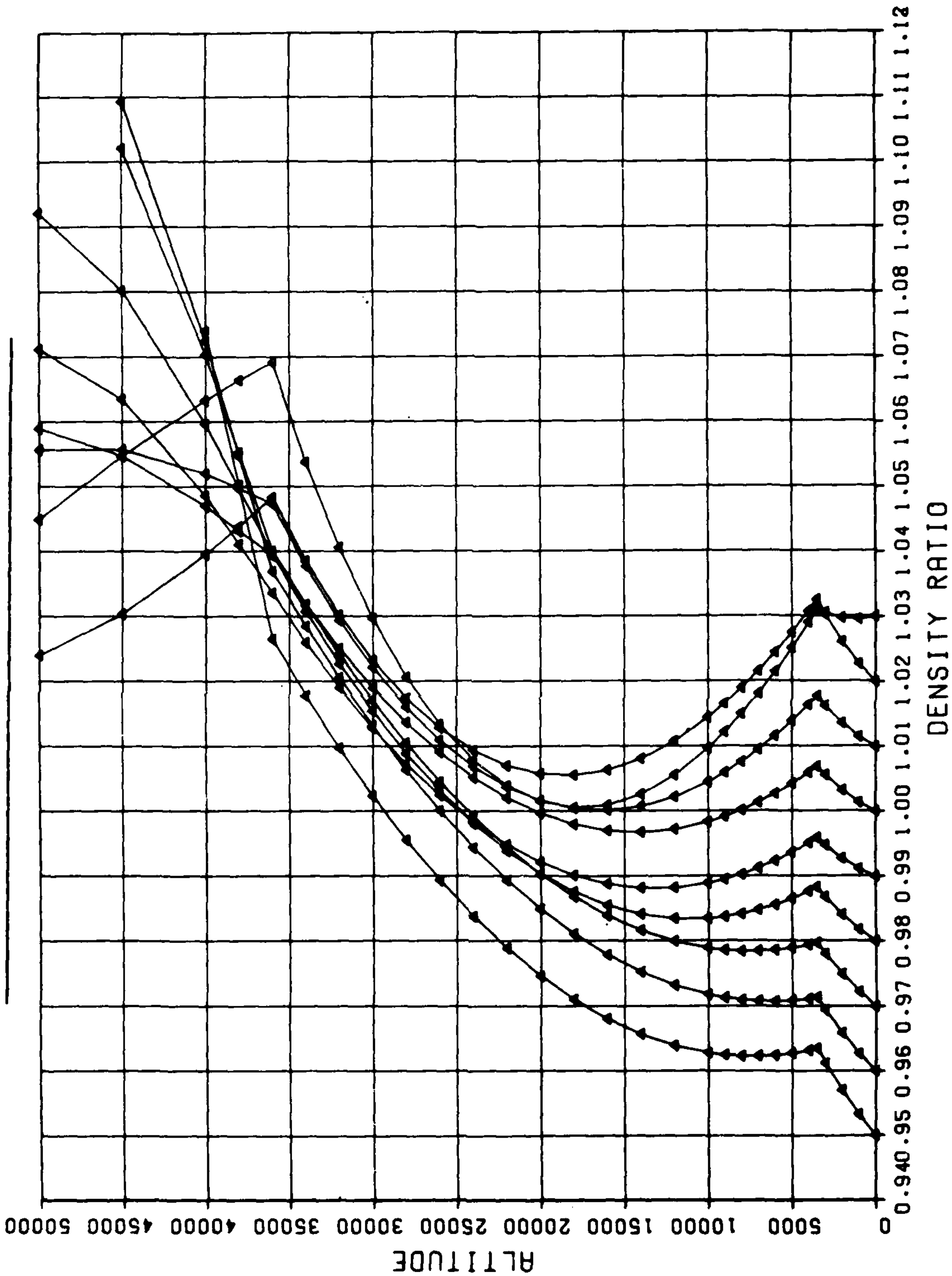


Station E
Fall 0000 hr G.m.t.
(20 hr 48 min local time)


Station E
Fall 1200 hr G.m.t.
(8 hr 48 min local time)
DENSITY RATIO
0.940.95 0.96 0.97 0.98 0.99 1.00 1.01 1.02 1.03 1.04 1.05 1.06 1.07 1.08 1.09 1.10 1.11 1.12
ALTITUDE
0 5000 10000 15000 20000 25000 30000 35000 40000 45000 50000

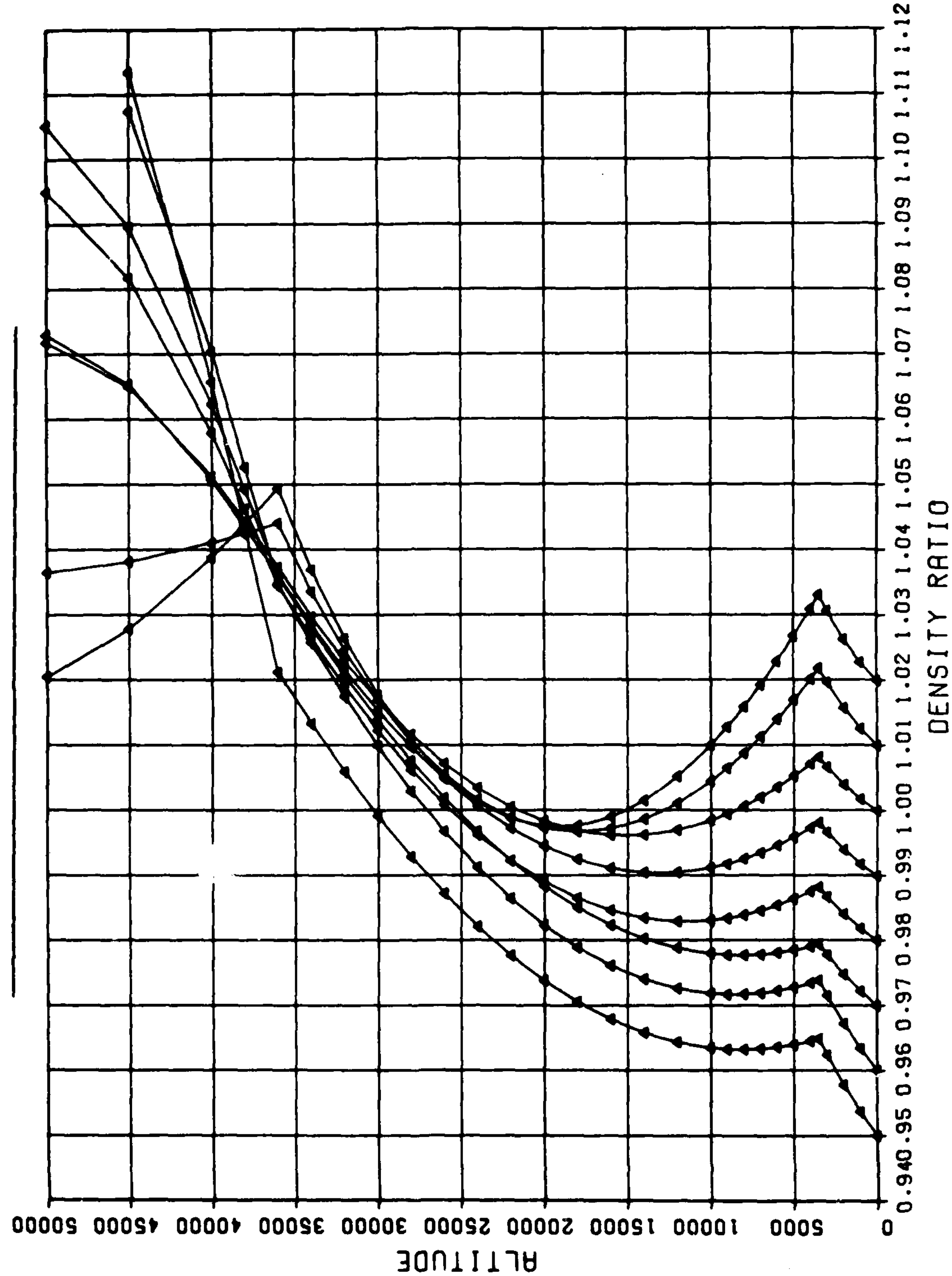

Station E
Winter 0000 hr G.m.t.
(20 hr 48 min local time)
DENSITY RATIO
0.94 0.95 0.96 0.97 0.98 0.99 1.00 1.01 1.02 1.03 1.04 1.05 1.06 1.07 1.08 1.09 1.10 1.11 1.12
ALTITUDE
0 5000 10000 15000 20000 25000 30000 35000 40000 45000 50000


Station E
Winter 1200 hr G.m.t.
(8 hr 48 min local time)
DENSITY RATIO
0.94 0.95 0.96 0.97 0.98 0.99 1.00 1.01 1.02 1.03 1.04 1.05 1.06 1.07 1.08 1.09 1.10 1.11 1.12
ALTITUDE
0 5000 10000 15000 20000 25000 30000 35000 40000 45000 50000



Station E
All Seasons 0000 hr G.m.t.
(20 hr 48 min local time)

Station E
All Seasons 1200 hr G.m.t.
(8 hr 48 min local time)



APPENDIX E

BALLISTIC DENSITY PROFILES FOR STATION E

AD-A119 496 NAVAL SURFACE WEAPONS CENTER DAHLGREN VA F/G 4/1
A METHOD TO CORRELATE THE UPPER AIR DENSITY WITH SURFACE DENSIT--ETC(U)
JUL 82 L J MCANELLY.
UNCLASSIFIED NSWC/TR-82-81 NL

2 OF 2

END
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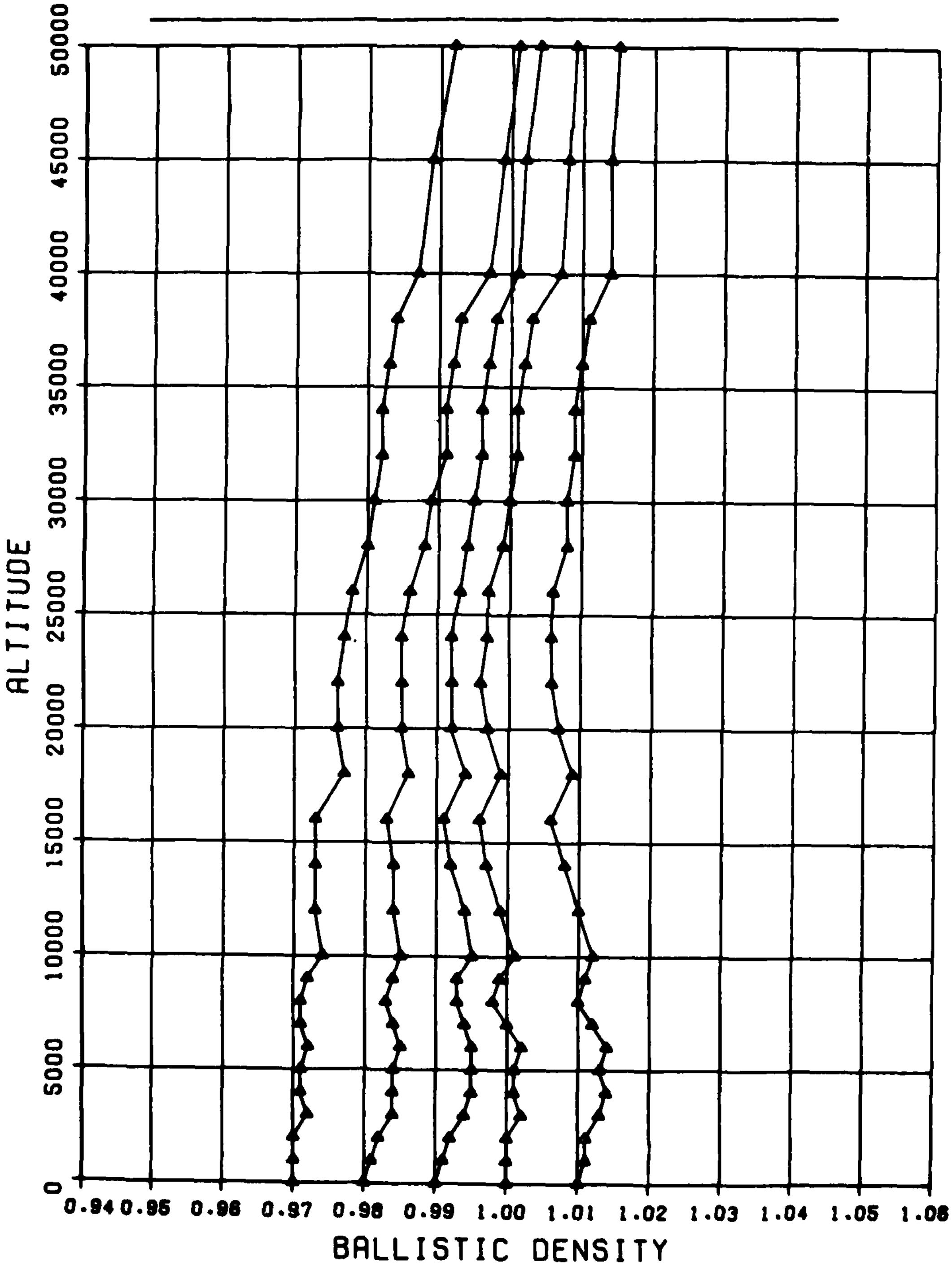
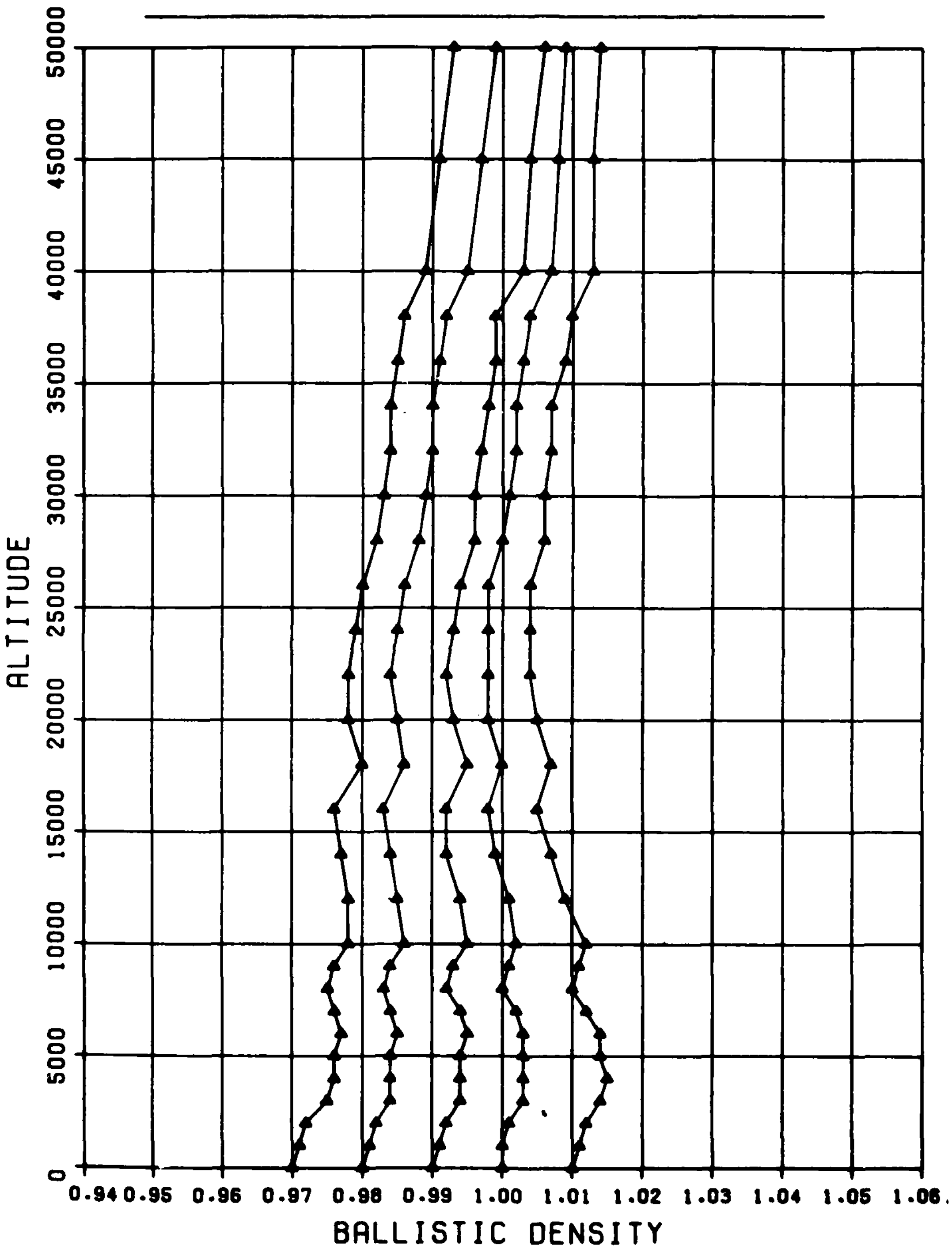
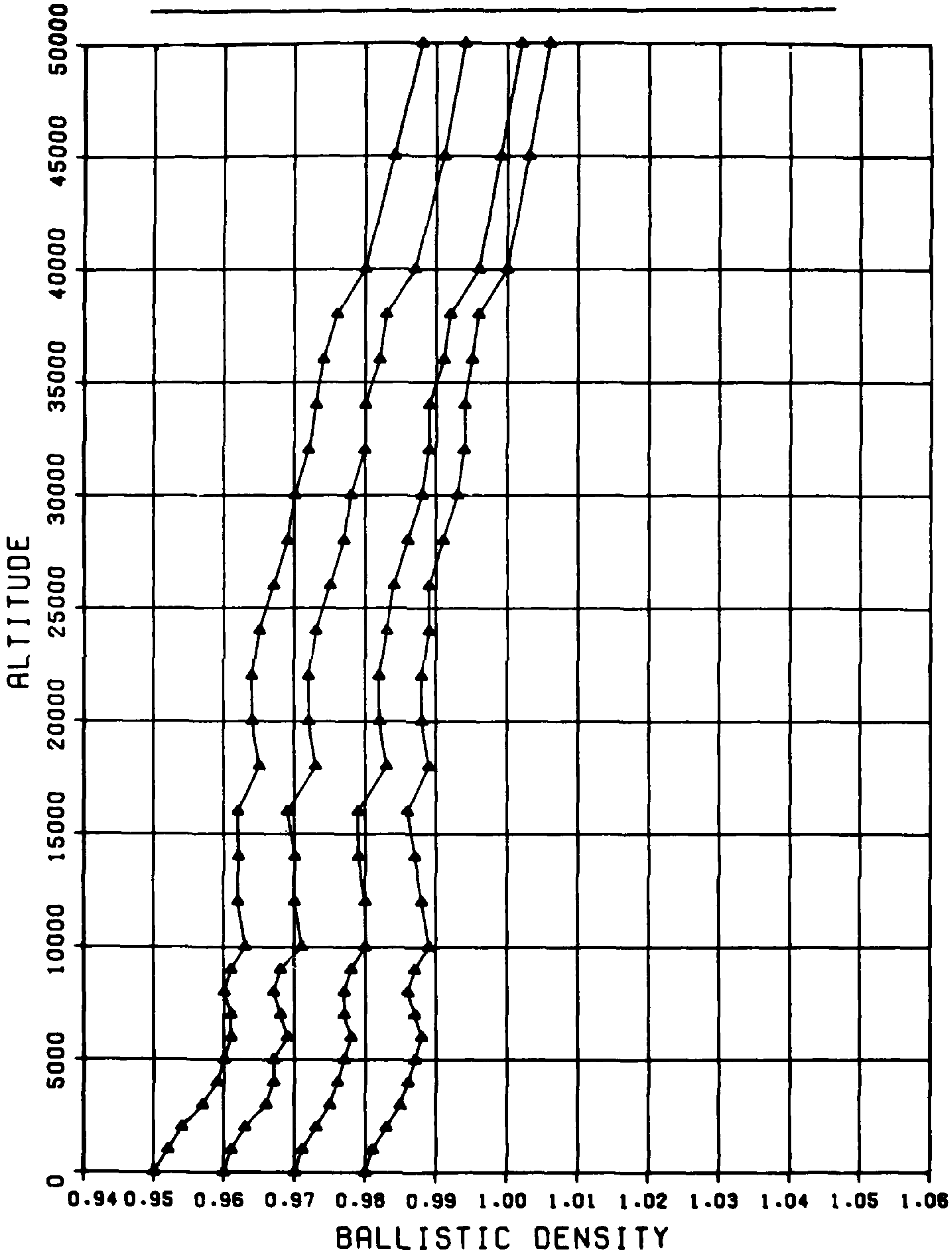
Station E
Spring 0000 hr G.m.t.
(20 hr 48 min local time)



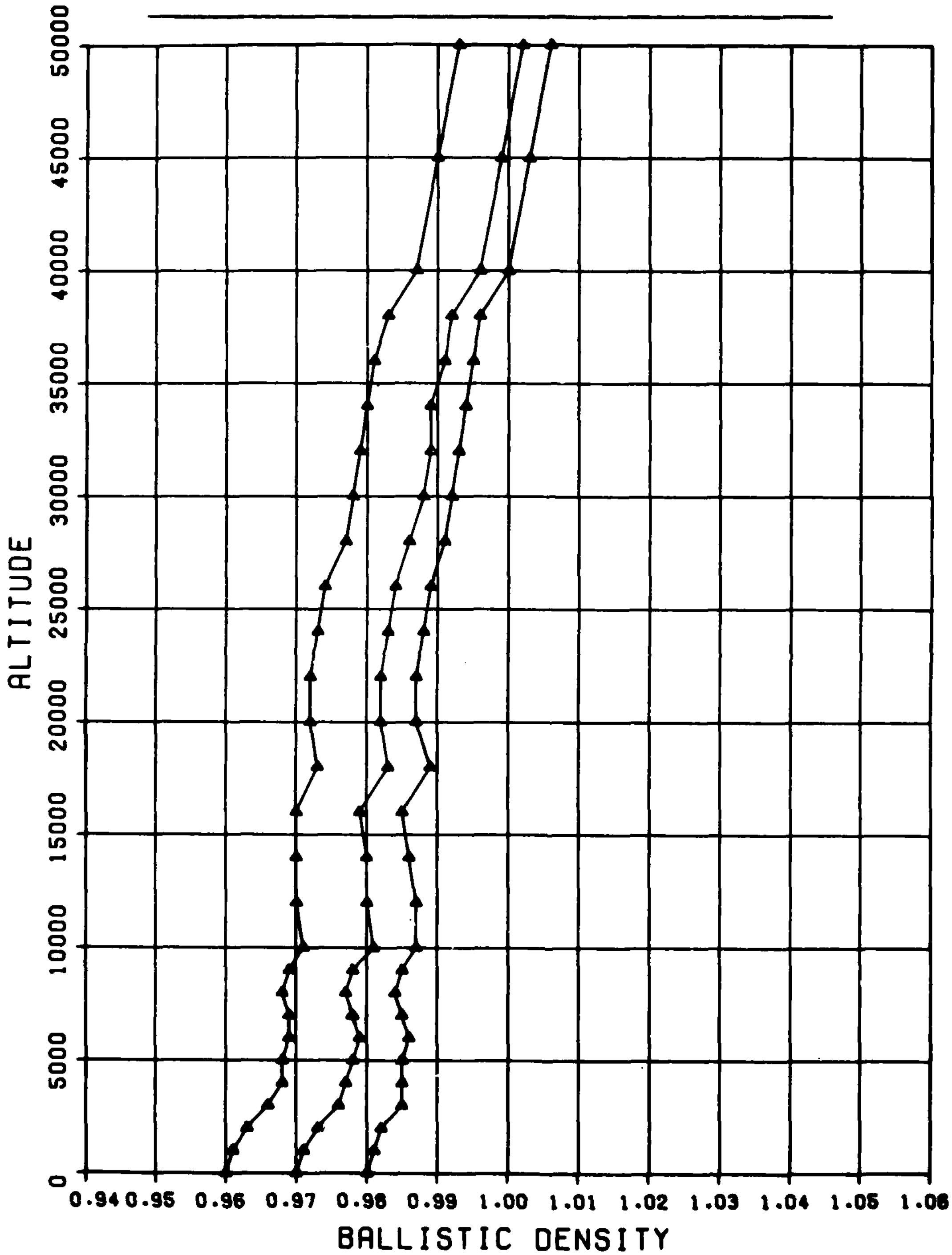
Station E
Spring 1200 hr G.m.t.
(8 hr 48 min local time)



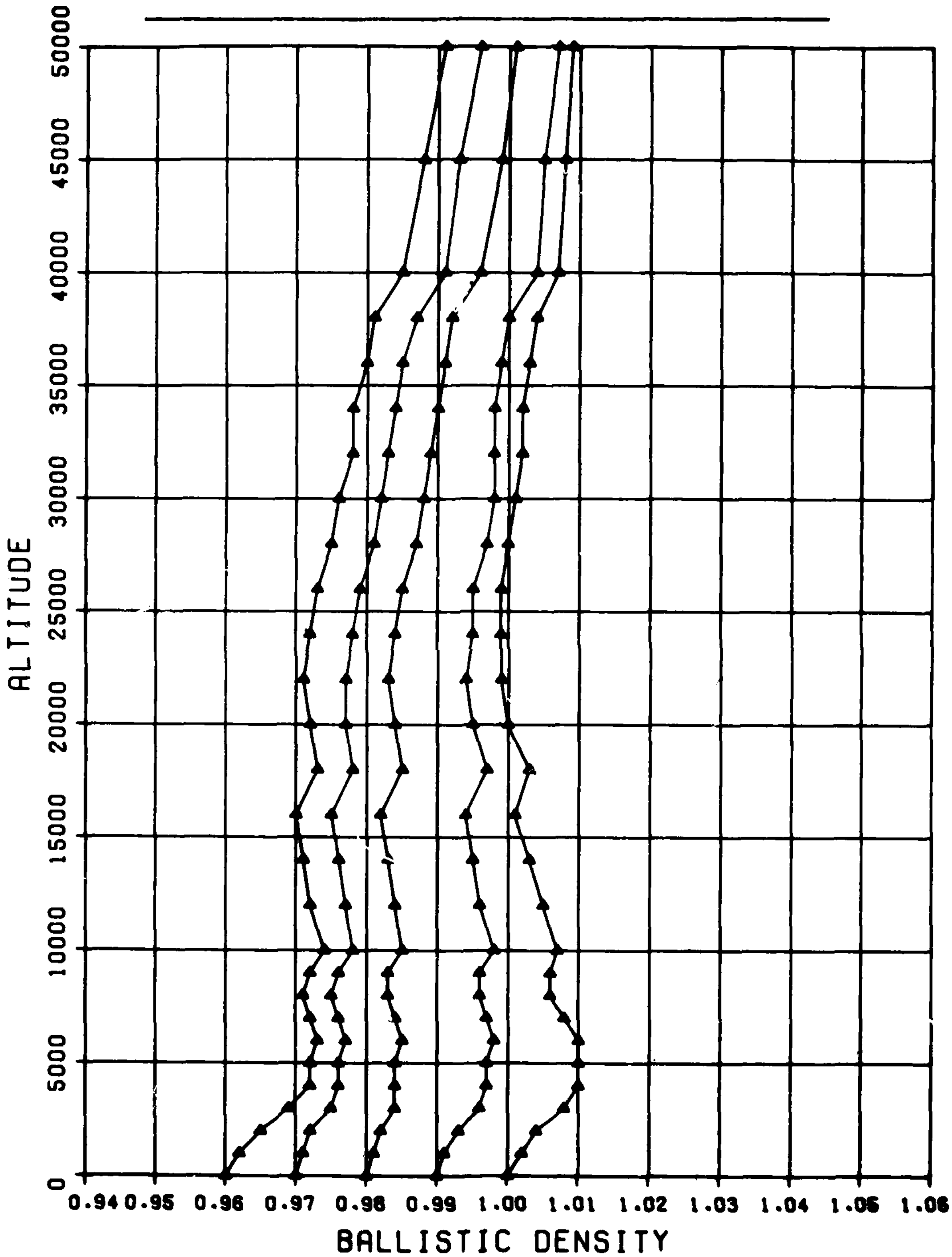
Station E
Summer 0000 hr G.m.t.
(20 hr 48 min local time)



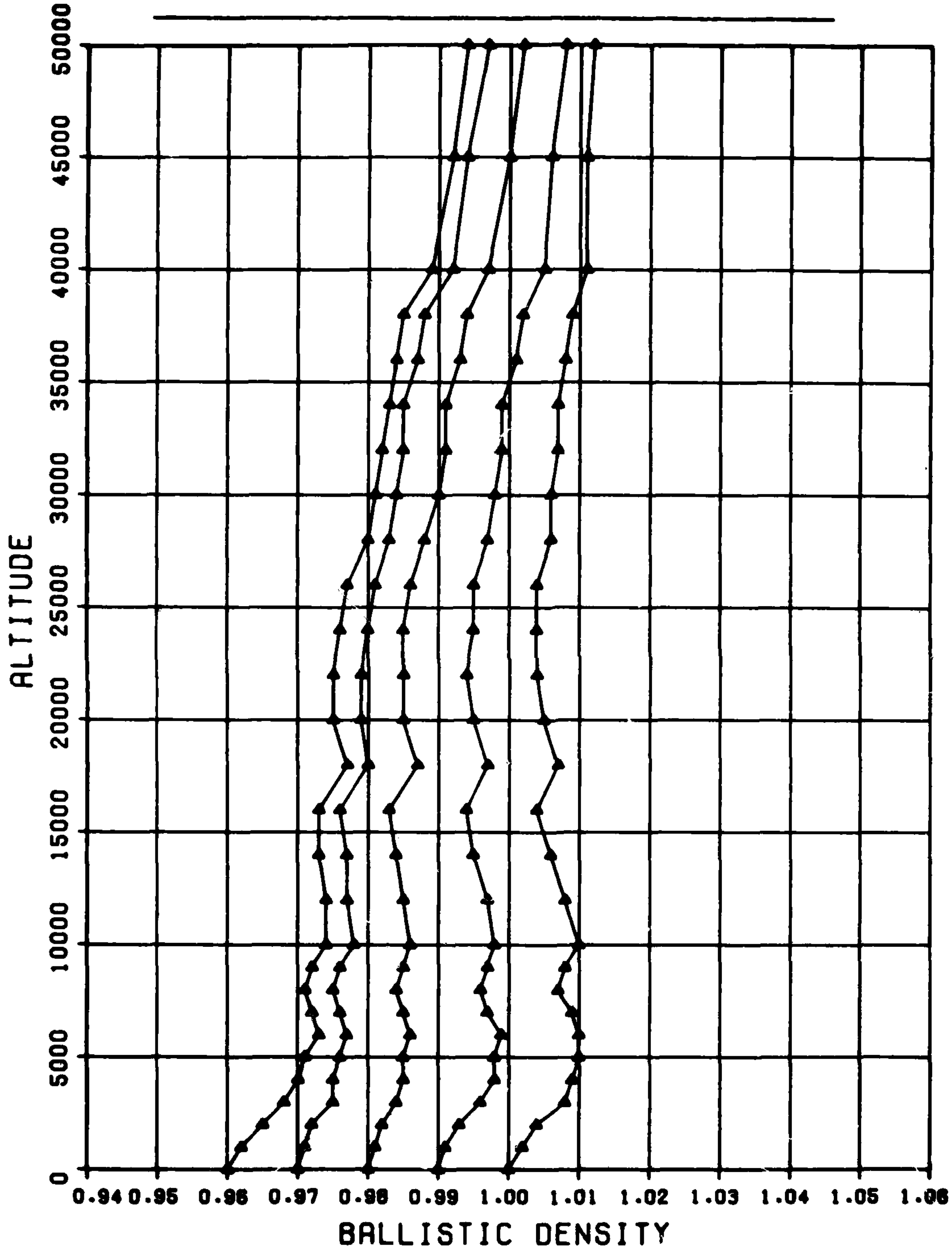
Station E
Summer 1200 hr G.m.t.
(8 hr 48 min local time)



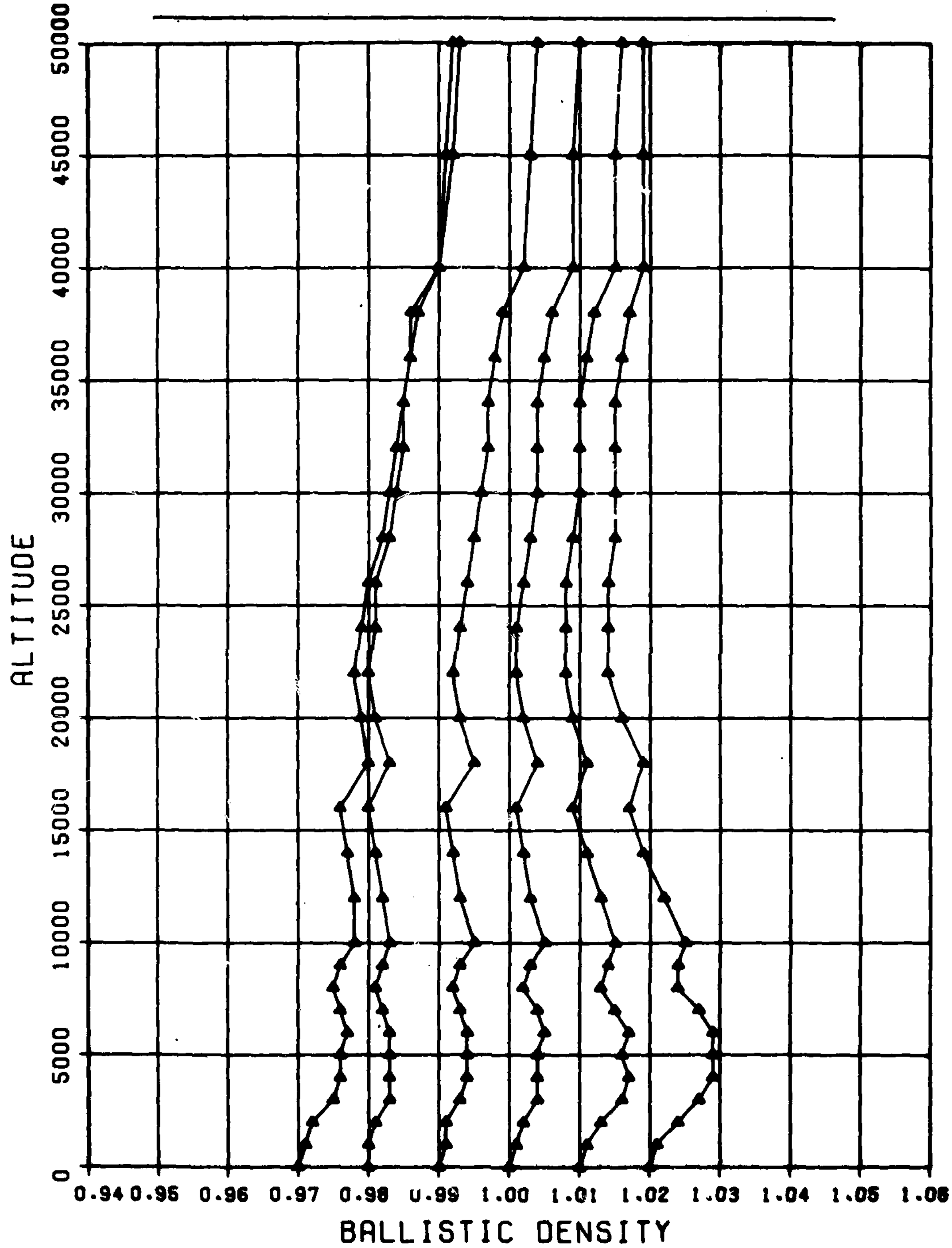
Station E
Fall 0000 hr G.m.t.
(20 hr 48 min local time)



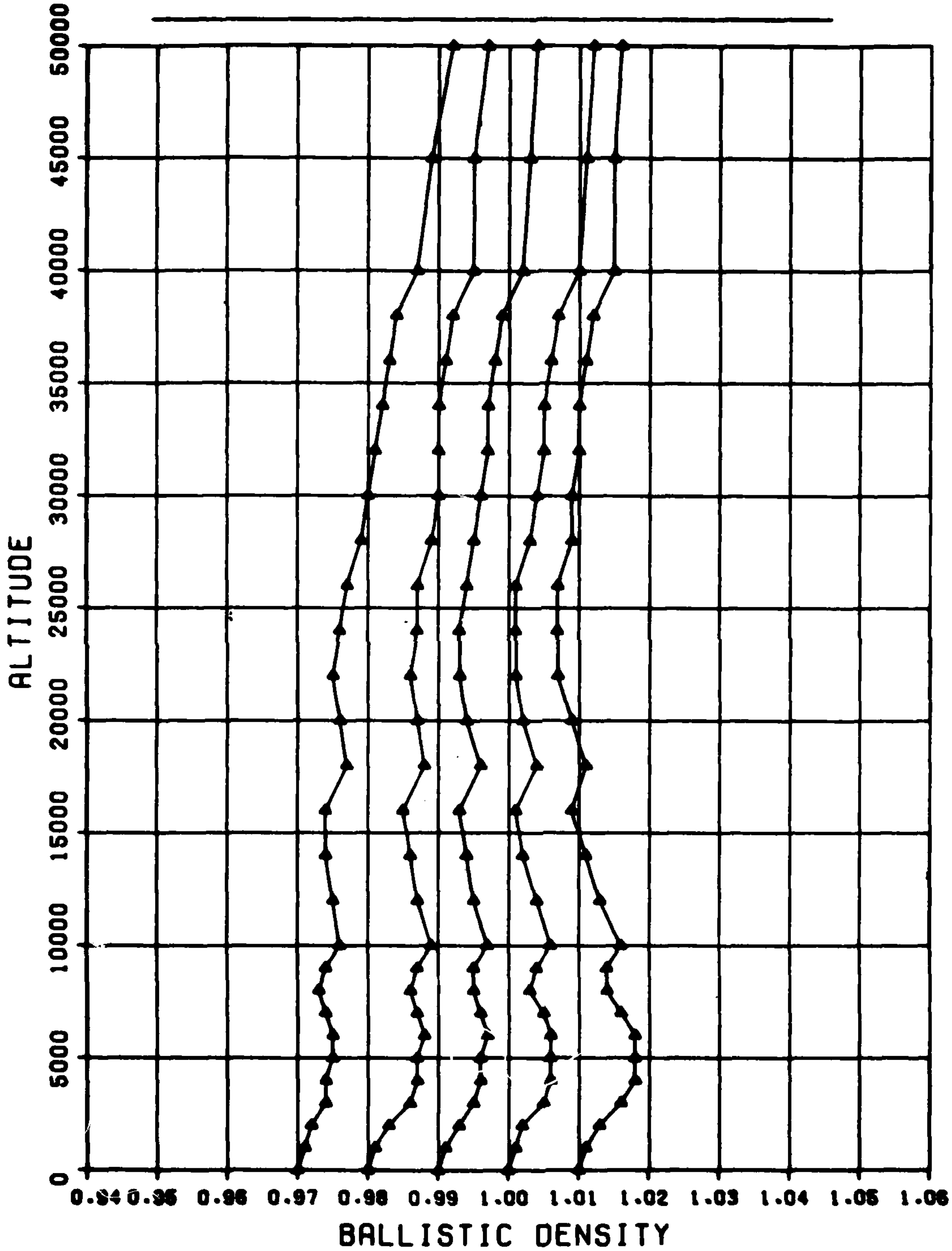
Station E
Fall 1200 hr G.m.t.
(8 hr 48 min local time)



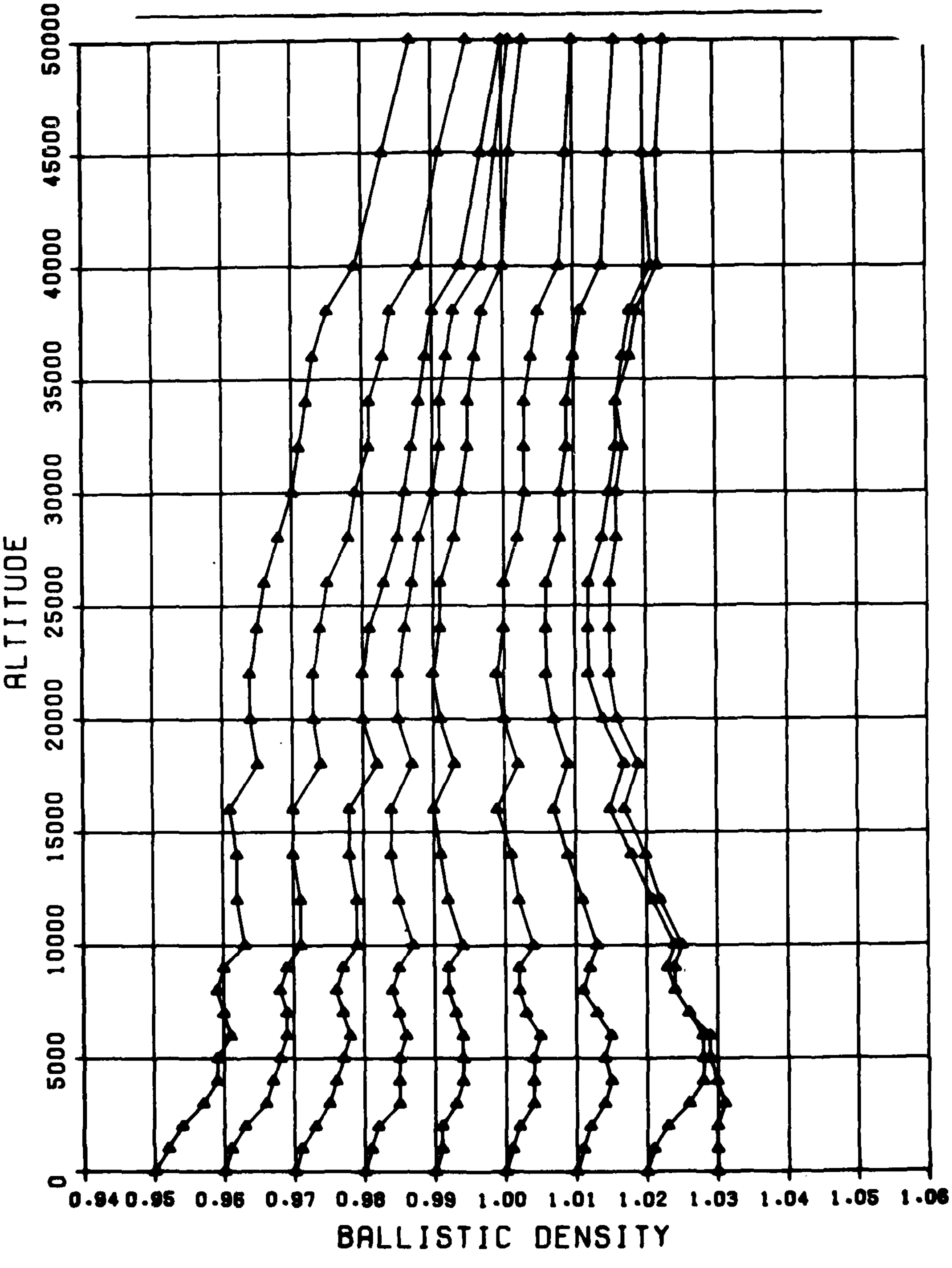
Station E
Winter 0000 hr G.m.t.
(20 hr 48 min local time)



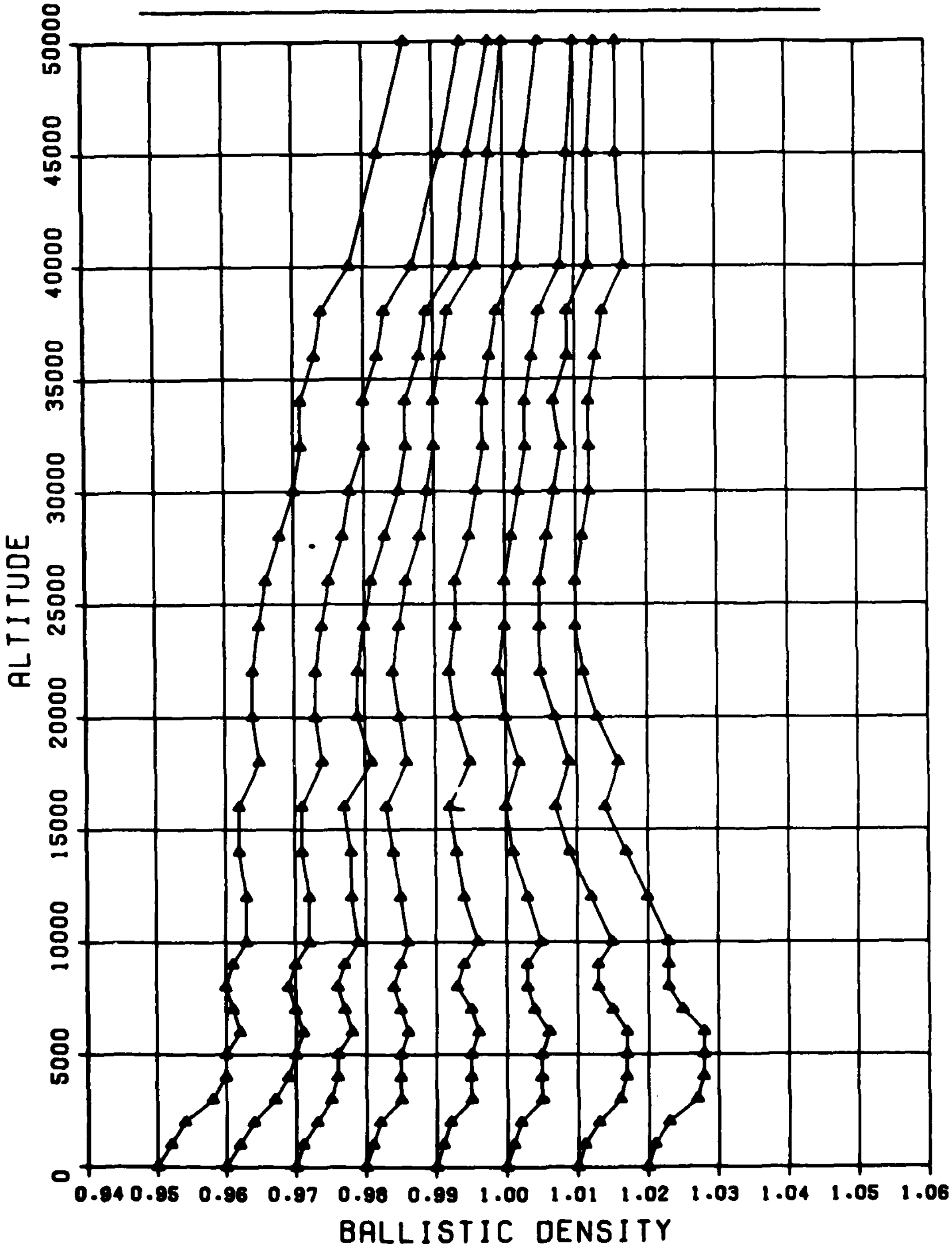
Station E
Winter 1200 hr G.m.t.
(8 hr 48 min local time)



Station E
All Seasons 0000 hr G.m.t.
(20 hr 48 min local time)



Station E
All Seasons 1200 hr G.m.t.
(8 hr 48 min local time)



APPENDIX F

SELECTED BALLISTIC DENSITIES FOR STATIONS E, [illegible] N, AND C

Local time corresponding to:

Station	0000 hr G.m.t.	1200 hr G.m.t.
E	20 hr 48 min	08 hr 48 min
V	10 hr 54 min	22 hr 54 min
C	21 hr 38 min	09 hr 38 min
D	21 hr 16 min	09 hr 16 min
N	14 hr 40 min	02 hr 20 min

(To be used with the following tables.)

BALLISTIC DENSITY

Altitude = 30,000 ft

Station	Surface Density	0000 hr G.m.t. W	S	SU	F	A	1200 hr G.m.t. W	S	SU	F	A
E	0.95	-	-	0.970	-	0.970	-	-	-	-	0.970
V		-	-	0.968	0.971	0.968	-	-	0.966	-	0.967
C		-	-	-	-	-	-	-	-	-	-
D		-	-	-	-	-	-	-	-	-	-
N		-	-	-	-	-	-	-	-	-	-
E	0.96	-	-	0.978	0.981	0.979	-	-	0.978	0.976	0.978
V		-	-	0.975	0.973	0.975	-	-	0.974	0.972	0.974
C		-	-	-	-	-	-	-	-	-	-
D		-	-	-	-	0.967	-	-	0.969	-	0.968
N		-	-	0.981	-	0.979	-	-	-	-	-
E	0.97	0.983	0.981	0.988	0.984	0.986	0.980	0.983	0.988	0.982	0.985
V		0.971	0.972	0.976	0.978	0.975	-	0.973	0.976	0.977	0.977
C		-	-	-	-	-	-	-	-	-	-
D		-	-	0.978	0.980	0.977	-	-	0.979	0.976	0.978
N		0.982	0.980	0.982	0.983	0.982	0.984	-	0.981	0.983	0.981
E	0.98	0.984	0.989	0.993	0.990	0.990	0.990	0.989	0.992	0.988	0.989
V		0.984	0.980	0.979	0.986	0.980	0.984	0.980	0.982	0.986	0.981
C		0.971	-	-	0.973	0.972	0.968	-	-	0.972	0.970
D		0.983	-	0.987	0.984	0.985	0.981	0.982	0.985	0.984	0.984
N		0.985	0.986	0.984	0.988	0.985	0.988	0.986	0.986	0.988	0.987

BALLISTIC DENSITY

Altitude = 30,000 ft

Station	Surface Density	0000 hr G.m.t.					1200 hr G.m.t.				
		W	S	SU	F	A	W	S	SU	F	A
E	0.99	0.996	0.995	0.987	0.998	0.994	0.996	0.996	-	0.998	0.996
V		0.991	0.986	0.984	0.995	0.991	0.992	0.987	-	0.993	0.989
C		0.977	0.978	0.979	0.980	0.978	0.980	-	0.978	0.980	0.980
D		0.988	0.989	0.992	0.991	0.992	0.990	0.991	0.991	0.990	0.991
N		0.994	0.990	0.989	0.994	0.993	0.993	0.989	0.990	0.996	0.992
E	1.00	1.004	1.000	-	1.006	1.003	1.004	1.001	-	1.001	1.002
V		0.999	0.995	-	1.001	0.998	0.998	0.993	-	1.003	0.995
C		0.986	0.987	0.987	0.987	0.986	0.985	0.983	0.985	0.986	0.984
D		0.996	0.995	0.995	0.998	0.997	0.997	0.995	0.995	0.996	0.994
N		1.003	0.998	-	1.000	1.000	1.001	0.999	-	1.002	1.000
E	1.01	1.010	1.008	-	-	1.008	1.009	1.006	-	-	1.007
V		1.006	1.001	-	-	1.005	1.004	0.999	-	-	1.003
C		0.993	0.992	0.991	0.994	0.993	0.992	0.989	0.990	0.994	0.992
D		1.002	1.002	-	1.000	1.002	1.002	1.000	-	1.002	1.002
N		1.009	-	-	-	1.010	1.011	1.007	-	-	1.009
E	1.02	1.015	-	-	-	1.016	-	-	-	-	1.012
V		1.011	1.009	-	-	1.008	1.008	1.007	-	-	1.009
C		1.002	0.996	0.997	1.001	0.998	1.001	0.999	0.999	1.002	0.999
D		1.009	1.005	-	1.010	1.008	1.008	1.004	-	1.008	1.009
N		-	-	-	-	-	-	-	-	-	-

BALLISTIC DENSITY

Altitude = 30,000 ft

Station	Surface Density	0000 hr G.m.t. W	0000 hr G.m.t. S	0000 hr G.m.t. SU	0000 hr G.m.t. F	0000 hr G.m.t. A	1200 hr G.m.t. W	1200 hr G.m.t. S	1200 hr G.m.t. SU	1200 hr G.m.t. F	1200 hr G.m.t. A
E	1.03	-	-	-	-	-	-	-	-	-	1.015
V		-	-	-	-	-	-	-	-	-	-
C		1.008	1.006	0.999	1.010	1.006	1.008	1.006	0.998	1.007	1.005
D		1.103	1.011	-	1.012	1.013	1.013	1.010	-	1.013	1.013
N		-	-	-	-	-	-	-	-	-	-
E	1.04	-	-	-	-	-	-	-	-	-	-
V		-	-	-	-	-	-	-	-	-	-
C		1.105	1.013	-	1.014	1.012	1.015	1.013	-	1.015	1.012
D		1.020	-	-	-	1.019	1.022	-	-	-	1.021
N		-	-	-	-	-	-	-	-	-	
E	1.05	-	-	-	-	-	-	-	-	-	-
V		-	-	-	-	-	-	-	-	-	-
C		1.024	1.018	-	-	1.021	1.019	1.019	-	-	1.018
D		1.028	-	-	-	1.027	1.027	-	-	-	1.026
N		-	-	-	-	-	-	-	-	-	-
E	1.06	-	-	-	-	-	-	-	-	-	-
V		-	-	-	-	-	-	-	-	-	-
C		-	-	-	-	-	1.029	-	-	-	1.028
D		-	-	-	-	-	-	-	-	-	-
N		-	-	-	-	-	-	-	-	-	-

BALLISTIC DENSITY

Altitude = 50,000 ft

Station	Surface Density	0000 hr G.m.t.					1200 hr G.m.t.				
		W	S	SU	F	A	W	S	SU	F	A
E	0.95	-	-	0.988	-	0.987	-	-	-	-	0.986
V		-	-	0.986	0.984	0.984	-	-	0.984	-	0.982
C		-	-	-	-	-	-	-	-	-	-
D		-	-	-	-	-	-	-	-	-	-
N		-	-	-	-	-	-	-	-	-	-
E	0.96	-	-	0.994	0.994	0.995	-	-	0.993	0.991	0.994
V		-	-	0.992	0.998	0.992	-	-	0.991	0.998	0.991
C		-	-	-	-	-	-	-	-	-	-
D		-	-	-	-	0.980	-	-	0.981	-	0.979
N		-	-	0.995	-	0.991	-	-	-	-	-
E	0.97	0.992	0.992	1.002	0.997	1.000	0.992	0.993	1.002	0.996	0.998
V		0.980	0.988	0.993	0.993	0.991	-	0.990	0.993	0.993	0.994
C		-	-	-	-	-	-	-	-	-	-
D		-	-	0.991	0.985	0.987	-	-	0.991	0.983	0.989
N		0.991	0.995	0.998	0.995	0.996	0.991	-	0.997	0.996	0.996
E	0.98	0.993	1.001	1.006	1.002	1.001	0.997	0.999	1.006	1.001	1.000
V		0.988	0.994	0.995	0.998	0.993	0.989	0.994	0.997	0.998	0.994
C		0.963	-	-	0.969	0.966	0.951	-	-	0.968	0.963
D		0.986	-	0.999	0.991	0.996	0.982	0.987	0.997	0.991	0.992
N		0.996	1.000	1.000	1.002	1.000	0.999	1.001	1.001	1.001	1.001

BALLISTIC DENSITY

Altitude = 50,000 ft

Station	Surface Density	0000 hr G.m.t. W	0000 hr G.m.t. S	0000 hr G.m.t. SU	0000 hr G.m.t. F	0000 hr G.m.t. A	1200 hr G.m.t. W	1200 hr G.m.t. S	1200 hr G.m.t. SU	1200 hr G.m.t. F	1200 hr G.m.t. A
E	0.99	1.004	1.004	1.003	1.008	1.003	1.004	1.006	-	1.007	1.005
V		0.996	0.999	1.000	1.004	1.000	0.995	1.000	-	1.003	0.998
C		0.966	0.971	0.980	0.975	0.976	0.965	-	0.980	0.977	0.978
D		0.990	0.995	1.002	0.999	1.001	0.990	0.996	1.004	0.999	1.000
N		1.004	1.004	1.005	1.008	1.007	1.003	1.004	1.005	1.008	1.005
E	1.00	1.010	1.009	-	1.012	1.010	1.012	1.009	-	1.009	1.010
V		1.000	1.004	-	1.006	1.002	0.998	1.004	-	1.008	1.002
C		0.982	0.984	0.990	0.986	0.988	0.976	0.979	0.989	0.986	0.987
D		0.997	1.003	1.007	1.005	1.005	1.000	1.002	1.006	1.003	1.002
N		1.011	1.010	-	1.012	1.010	1.012	1.010	-	1.013	1.011
E	1.01	1.016	1.015	-	-	1.016	1.016	1.014	-	-	1.013
V		1.006	1.008	-	-	1.007	1.003	1.009	-	-	1.005
C		0.988	0.991	0.995	0.993	0.993	0.988	0.989	0.996	0.994	0.996
D		1.005	1.006	-	1.004	1.007	1.003	1.006	-	1.006	1.007
N		1.016	-	-	-	1.017	1.017	1.017	-	-	1.017
E	1.02	1.019	-	-	-	1.020	-	-	-	-	1.016
V		1.009	1.014	-	-	1.011	1.008	1.013	-	-	1.009
C		0.995	0.998	1.002	1.000	0.999	0.997	0.998	1.003	1.001	1.001
D		1.006	1.010	-	1.010	1.009	1.004	1.009	-	1.012	1.008
N		-	-	-	-	-	-	-	-	-	-

BALLISTIC DENSITY

Altitude = 50,000 ft

Station	Surface Density	0000 hr G.m.t. W	S	SU	F	A	1200 hr G.m.t. W	S	SU	F	A
E	1.03	-	-	-	-	-	-	-	-	-	1.023
V		-	-	-	-	-	-	-	-	-	-
C		1.000	1.007	1.005	1.008	1.007	1.003	1.006	1.004	1.008	1.004
D		1.010	1.015	-	1.016	1.011	1.009	1.015	-	1.014	1.011
N		-	-	-	-	-	-	-	-	-	-
E	1.04	-	-	-	-	-	-	-	-	-	-
V		-	-	-	-	-	-	-	-	-	-
C		1.008	1.008	-	1.015	1.009	1.009	1.011	-	1.013	1.009
D		1.015	-	-	-	1.015	1.015	-	-	-	1.016
N		-	-	-	-	-	-	-	-	-	-
E	1.05	-	-	-	-	-	-	-	-	-	-
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